JOURNAL OF DAIRY SCIENCE

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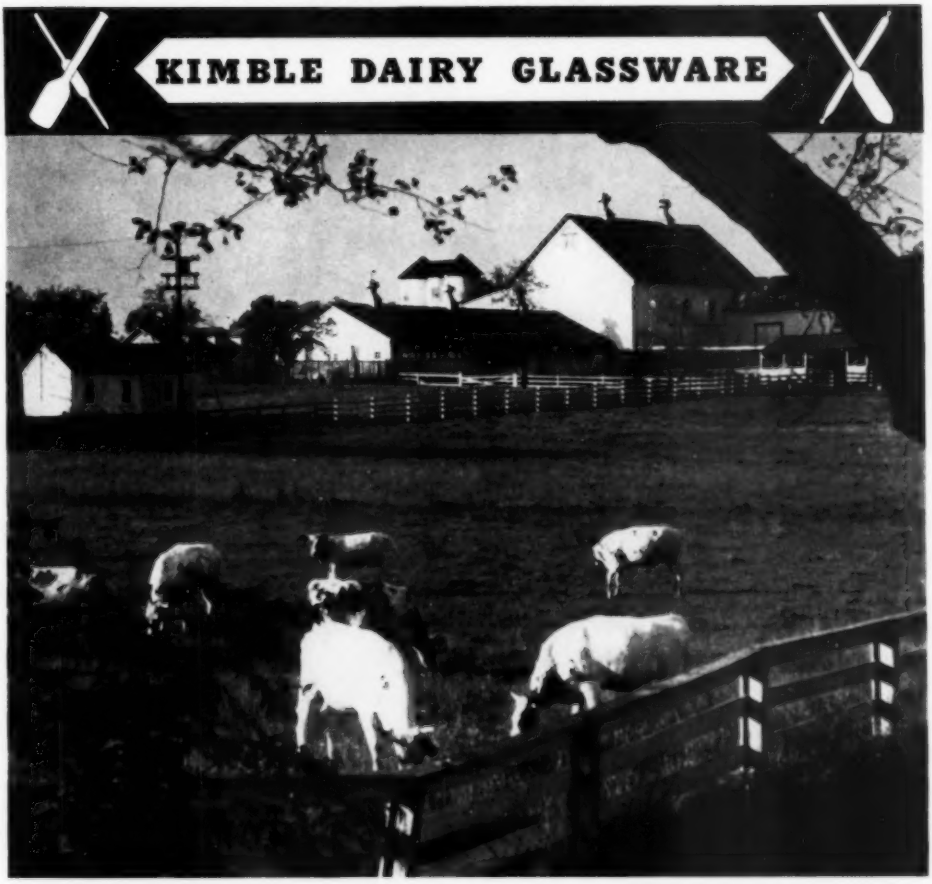

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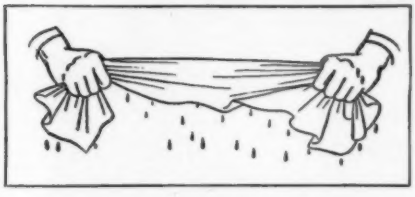

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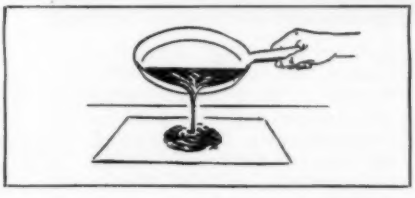

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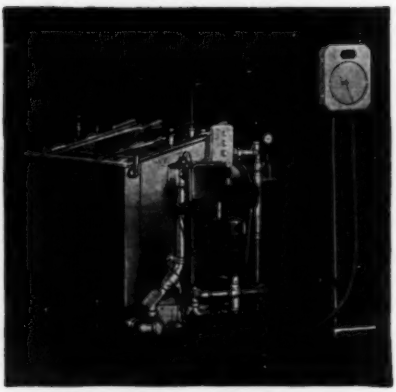

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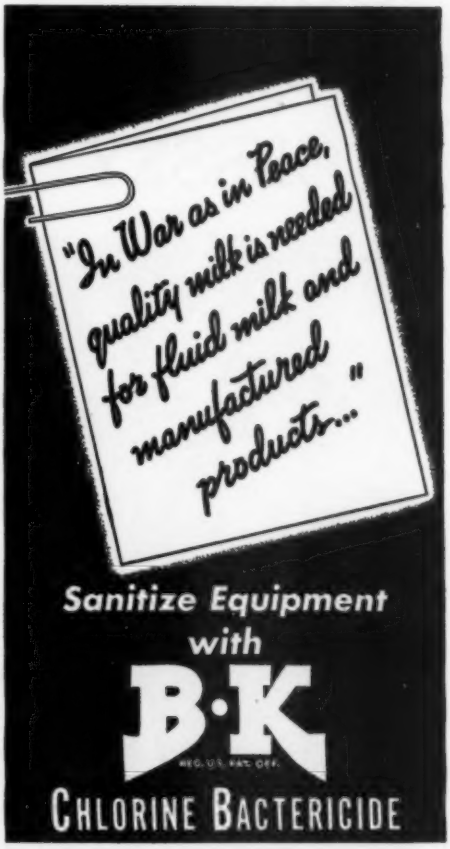
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JOURNAL OF DAIRY SCIENCE

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THE EFFECT OF HIGH-TEMPERATURE-SHORT-TIME HEATING OF CONCENTRATED MILK UPON ITS HEAT STABILITY

B. H. WEBB AND R. W. BELL

Division of Dairy Research Laboratories, Bureau of Dairy Industry, Agricultural Research Administration, U. S. Department of Agriculture

In the manufacture of evaporated milk the raw milk is always forewarmed to protect it against bacterial and enzymic action and to control the heat stability of its concentrate during sterilization. "Double cooking" (3) or "superheating" (1) the concentrated milk in an attempt to increase its heat stability, although occasionally practiced, is not favored by most manufacturers. When the concentrated milk is subjected to temperatures up to 100° C. in hotwells or vacuum pans its viscosity is generally increased and its heat stability is often decreased.

It is important that manufacturers of evaporated milk know the different methods by which the heat stability of milk may be increased. The results of earlier investigations (4, 5) have shown that high-temperature-short-time forewarming of the raw milk can be used to increase the heat stability of its concentrated product. This report will show how high-temperature-short-time heating of the concentrated milk likewise can be used to increase its heat stability.

EXPERIMENTAL

The methods and equipment used in this work were the same as those described in a recent paper (5). The milk was from the Beltsville herd of the Bureau of Dairy Industry and the whole milk was standardized to a fat to solids-not-fat ratio of 1 to 2.29.

Three types of heat treatment were used in processing the milk. Forewarming was the first heat treatment received by the raw milk before it was drawn into the vacuum pan for concentration. All samples were forewarmed. The control samples and some of the test samples were forewarmed at 95° C. (203° F.) for 10 minutes while a few test samples were forewarmed at higher temperatures.

After being forewarmed, the milk was concentrated. The concentrated whole milk was homogenized at 60° C. (140° F.) and 2500 pounds per square

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inch pressure. Some of the samples were then subjected to the second heat treatment which, when conducted in the high-temperature-short-time heater, differed from the old methods of "double cooking" and "superheating" in both the technique used and in the results obtained. The step of heating the concentrate is the variable characteristic with which this paper is concerned. The time, temperature and method of heating the concentrate is specified. The whole milk solids in the concentrates ranged from 26 to 37 per cent.

The equipment used for forewarming the raw milk and for heating the concentrated samples was of two types. A conventional steam-jacketed hotwell was generally used for heating samples to temperatures below 100° C. Whenever treatment at 95° C. for 10 minutes is mentioned in this paper it refers to heating in this steam jacketed hotwell. All heating above 100° C. was accomplished in a Mallory heater which required only 3 seconds to heat the milk to the required temperature and 3 seconds to cool it.

The heat stability of all samples was found by means of the third heat treatment used in this work. This heating consisted of the procedure customarily followed during the sterilization of evaporated milk in cans. The concentrated milk samples were heated in small cans in a pilot sterilizer at 115° C. (239° F.). The time of heating at this temperature required to initiate coagulation in a concentrate was recorded as its heat stability.

RESULTS

Data showing the effect of the conventional hotwell method of heating concentrated milk upon its heat stability are presented in table 1. The three different milks represented in this table were treated after concentration by heating about seven pounds of milk in steel pans in a steam bath. The water evaporated was replaced. The relatively small changes in heat stability brought about by heating the concentrated milk in this manner were comparable to results which might have been obtained by using the commercial practice of "double cooking."

TABLE 1

The effect upon heat stability of using the conventional hotwell method to heat milk after concentration to 26% solids content. All milks were forewarmed at 95° C. (203° F.) for 10 minutes before concentration

Date	Heat treatment after concentration		Heat stability—(time to initiate coagulation at 115° C.)
	Temperature	Time	
	°C.	min.	min.
9–25–42	None	None	40
"	95	10	45
"	95	20	40
10– 5–42	None	None	28
"	95	10	21
12–18–42	None	None	17
"	91	10	12

The curves plotted in the following figures indicate how large an increase in heat stability may be produced by using the high-temperature-short-time method of heating on concentrated milk. The importance of small increments of time and temperature of heating upon heat stability is illustrated in figure 1. The concentrate attained maximum stability when a temperature of 150° C. with no holding time was used.

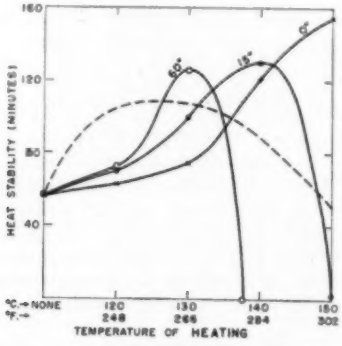

FIG. 1. The effect upon heat stability of heating a milk to different temperatures for different periods of time. The solid lines represent samples forewarmed at 95° C. (203° F.) for 10 minutes before concentration to 26% solids content and heated after concentration for the times and at the temperatures designated in the figure. The dotted line represents milk samples which were forewarmed before concentration at the temperatures indicated, then concentrated to 26% solids content but not heated after concentration. "None" on the abscissa refers to control samples which were forewarmed at 95° C. for 10 minutes before concentration but were not heated after concentration. Heat stability refers to the time necessary to initiate coagulation at 115° C. (239° F.).

The results of high-temperature-short-time heating of milks of 26 per cent solids content and higher upon their heat stability are shown in figure 2. Control samples were forewarmed at 95° C. for 10 minutes or at 120° C. for 4 minutes and were not heated after concentration. In all cases heat stability was improved by heating the concentrate.

The data of figures 1 and 2 were obtained by using a forewarming temperature of 95° C. for 10 minutes or above before concentration of the milks. The effect of using a low forewarming temperature is shown in figure 3. Heating the concentrate markedly increased its heat stability when the raw milk had previously been forewarmed to either 65° C. or 95° C.

The effect of heating concentrated skim milk differed from that of heating concentrated whole milk. Data which are typical of the results obtained on three different batches of milk are plotted in figure 4. Heating skim milk of 18.5 per cent solids content in the range of 135° to 145° C. caused a lessening of heat stability.

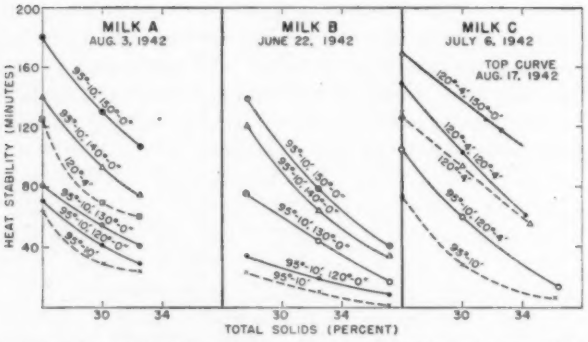

FIG. 2. The effect of high-temperature short-time heating of three milks before and after concentration upon their heat stabilities. The designation "95°–10′" refers to the conventional hotwell method of forewarming; all other temperatures were attained in the special high temperature equipment. All temperatures on the figures are in degrees Centigrade. The first temperature-time figures on each curve indicate the treatment the milk received before concentration; the second set of figures gives the treatment after concentration. The dotted lines represent control samples forewarmed before concentration only.

DISCUSSION

High-temperature-short-time heating of concentrated milks increased their heat stabilities. The heat stabilities of the same concentrated milks were changed but little by subjecting them to heating equivalent to the conventional heat treatment of 95° C. for 10 minutes. The optimum forewarm-

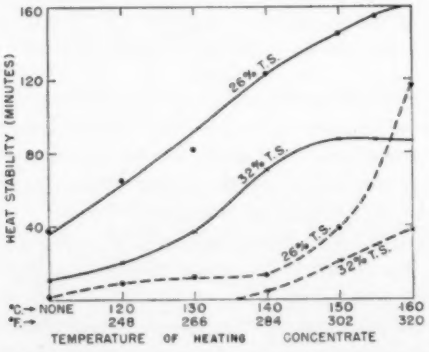

FIG. 3. Effect of two temperatures of hotwell forewarming before concentration upon the heat stability of samples of the same milk heated to different temperatures after concentration. The solid lines indicate samples forewarmed at 95° C. (203° F.) for 10 minutes, dotted lines indicate samples forewarmed at 65° C. (149° F.) for 10 minutes before concentration. The control samples were not heated after concentration. Heat stability refers to the time necessary to initiate coagulation at 115° C. (239° F.). Zero holding time was used in heating the concentrates.

ing conditions for Beltsville Research Center raw milk have been established at 120° C. for 3 to 4 minutes (5). Heating the concentrate to 150° C. with no holding time was most effective in increasing its heat stability. Maximum heat stability was attained by forewarming at 120° C. for 4 minutes before concentration and by heating at 150° C. with no holding time after concentration.

When there was no holding period during heating of the concentrate, its heat stability increased at a relatively slow but continuous rate until a maximum was reached just before coagulation was initiated. Therefore, increasing the heat stability by heating the concentrate without any holding time or with one of only a very brief period is indicated by the curves. However,

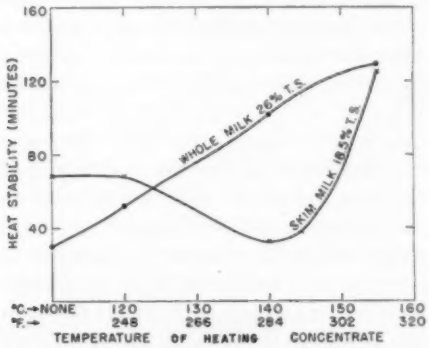

FIG. 4. The effect upon heat stability of heating whole and skim samples of the same milk at 95° C. (203° F.) for 10 minutes and their concentrates to the designated temperatures for zero holding time. Heat stability refers to the time necessary to initiate coagulation at 115° C. (239° F.).

by using a holding period, it was not necessary, within the limits shown by the curves in figure 1, to heat to as high a temperature to obtain the same heat stability as it was without a holding period.

Many differences in the heat stability of the finished evaporated milk may be obtained through the use of different combinations of times and temperatures of heating used before and after concentration. While 120° C.–4′, 150° C.—0″ produced maximum stability on Beltsville milk, lower stabilities were obtained by lowering the forewarming temperature to 95° C. or below. Figure 3 shows the range of stability which was obtained when the raw milk was forewarmed at 65° C. and 95° C.

Changes in body and in other characteristics of evaporated milk in storage accompany changes in heat stability. Maximum heat stability may not be desirable. A heat treatment should not be selected because it gives maximum heat stability, but because it gives sufficient heat stability to permit the product to be sterilized and to give it proper body and a good color.

The optimum heat stability range for the production of an evaporated milk satisfactory in all respects lies between 22 and 40 minutes.

Milks which coagulate in a shorter time than 22 minutes at 115° C. (239° F.) will, if processed 18 or 20 minutes at this temperature, show an excessively heavy body while those with a coagulation time greater than 40 minutes will be too thin. Later reports will be concerned with the body and storage characteristics of evaporated milks. The subject is mentioned here to caution against the production of extremes of heat stability in milks which are to be processed.

The heating of milk after concentration for the purpose of regulating its heat stability during sterilization would give the manufacturer the same control over the body of his product as he now has through the addition of stabilizing salts. Test runs with added salts are now used to indicate the quantity of salt required to obtain a certain body. Test runs of the concentrate would likewise indicate the heating which the batch would require to produce a specified body.

The question may well be raised as to what effect a temperature above 140° C., even with no holding time, may have on milk of high solids concentration. The color of experimental samples was darkened but not to an excessive extent and there was a slight intensification in the cooked flavor. Milks of insufficient protein stability, when preheated to too high a temperature, developed a partial, but hard and flaky coagulum. These flakes of denatured casein were sometimes not apparent in the evaporated milk until they slowly formed a sediment on the bottom of the cans during storage.

Since some of the conditions used to heat the concentrated milk samples approach those which could be expected to produce sterility, the possibility thus arises of using high temperature heating of the concentrated milk not only to increase its heat stability, but also as an aid in the sterilizing process. Of several dozen cans of milk from 6 different batches cooked at 115° C. for 5, 10 and 18 minutes, only one of the 5-minute cans showed spoilage after six months storage at 30° C. Care was taken in filling and sealing the cans to avoid undue contamination but no equipment was sterilized. Samples of milk heated as a concentrate and processed in cans at 115° C. for 5 to 10 minutes had less color and cooked flavor than milk treated by the usual methods. Much work must still be done on this phase of the problem before it can be tried on a commercial scale. Flavor, color, body and bacteriological studies must be made with samples subjected to different processes.

SUMMARY

1. High-temperature-short-time heating of concentrated milk increased its heat stability to a maximum and then decreased it. With no holding time the heat stability increased with rise in temperature up to the point of initial coagulation. Factors which controlled the attainment of maximum

heat stability were the time and temperature of forewarming the raw and of heating the concentrated milk and the solids content of the concentrate. The greatest heat stability was obtained when the raw milk was heated at 120° C. (248° F.) for 4 minutes and the concentrate to 150° C. (302° F.) with no holding period.

2. Great differences in heat stability resulted from changes in the time and temperature of forewarming. Samples of raw milk were forewarmed at temperatures of 65° C. (149° F.) to 120° C. (248° F.) and held from zero to 10 minutes. After concentration these samples were heated to temperatures of 95° C. (203° F.) to 150° C. (302° F.) and held from zero to 20 minutes.

3. The most desirable heat treatment is not always the one that gives maximum stability, since the effect of the heat treatment on the body and color of the milk being processed must also be considered. Heating of the milk after concentration permits a close control of the body of the sterilized product without the use of stabilizing salts.

4. High-temperature-short-time heating the concentrated milk to attain the desired heat stability offers the possibility of modifying the commercial sterilizing methods by reducing the length of the conventional "cooking" period in the can. This would, of course, require the use of previously sterilized cans and a highly sanitary technic. Thus an evaporated milk of superior color and flavor could be produced.

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STUDIES ON KETOSIS IN DAIRY CATTLE. V. THE DEVELOPMENT OF KETOSIS[1]

J. C. SHAW

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In seeking for the cause of ketosis in cattle it is of considerable importance to know at what period in the lactation cycle the condition begins to develop. Boddie (1) states that the predominance of clinical cases of ketosis occurs during the first few months following parturition. Duncan, Huffman, and Tobin (2) observed that ketosis is most noticeable from two to six weeks following parturition. Studies on normal cows at this station (4) failed to show any relationship between the lactation cycle and either the blood or urinary acetone bodies. Godden and Allcroft (3), on the other hand, observed a decrease in blood glucose in the first week following parturition in cows presumed to be normal.

Several reviews on ketosis in the ruminant have appeared in the literature. A particularly concise review of the fundamental aspects of ketosis was recently published by Roepke (5).

This paper reports a study of the onset of ketosis in cattle in which particular attention was given to the periods immediately preceding and following the development of this condition.

EXPERIMENTAL

A herd of high producing Holstein cattle, in which the incidence of ketosis had been high for a period of several years, was selected for study.

Blood glucose and acetone bodies (expressed as acetone) were determined at short intervals, prior to and following parturition, on a number of cows, several of which developed ketosis. Glucose tolerance and glycogen storage tests were also made. The methods used for blood glucose and acetone bodies and for the arteriovenous studies were described in previous publications (7, 8).

Sixteen cows in the herd calved during the period of this study; 12 of them developed some degree of ketosis. Of these, five did not show any symptoms. Four were somewhat lethargic and had poor appetites for a few days. Only three exhibited marked symptoms of ketosis. Two other cows, which had developed ketosis before this study was initiated, were also included. First-calf heifers were not included in this study. The observations were started in July, 1942, and continued through September of that year. The incidence of ketosis in the herd in the months immediately pre-

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ceding this study had been equally high and the severity greater. Most of the cows calving during that period showed marked symptoms of ketosis and were treated by intravenous glucose injections. Possibly the lessened severity of the ketosis during the period of this study was due to a small amount of pasture which was available to the herd during the summer months; previous work (9) has indicated that pasture grass has an anti-ketogenic effect.

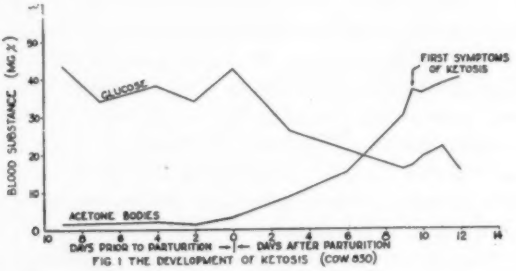

FIG. 1 THE DEVELOPMENT OF KETOSIS (COW 830)

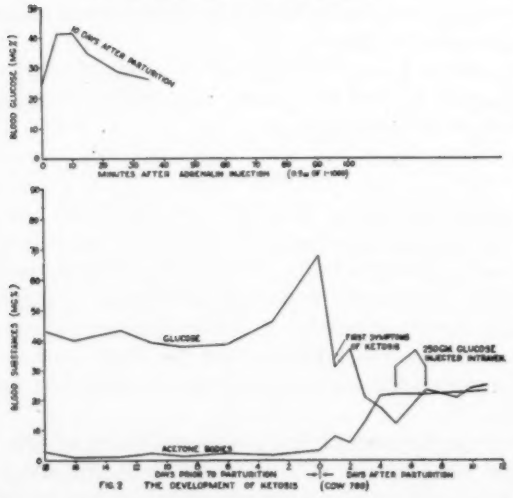

FIG. 2 THE DEVELOPMENT OF KETOSIS (COW 760)

The blood picture during the development of ketosis. The concentration of blood glucose and acetone bodies during the development of six cases of ketosis of varying degrees of severity are presented in figures 1 to 5. In all cases the development of hypoglycemia and ketonemia began within one to three days after parturition and continued for four to ten days before the most marked hypoglycemia was observed.

Probably the most interesting cases were those of cows 830 and 760 (figures 1 and 2). Both animals exhibited marked symptoms of ketosis.

However, cow 830 developed ketosis over a period of nine days before exhibiting any symptoms; whereas cow 760 showed marked incoordination the day following parturition. The appetite and alertness of the latter cow appeared quite normal, however, until the fifth day after parturition, when the blood glucose had decreased to 12 mg. per cent. Cow 830 showed the first symptoms of ketosis nine days after parturition, when the blood glucose had decreased to 16 mg. per cent.

Although the energy intake during the first few weeks following calving was maintained at a level sufficient for their maintenance and milk production, both cows exhibited hypoglycemia and ketonemia for about six weeks and became quite emaciated.

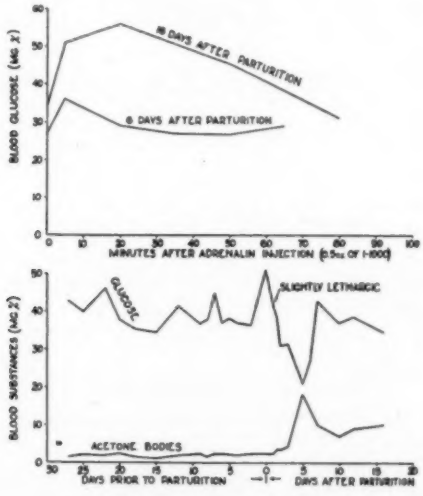

FIG 3 THE DEVELOPMENT OF KETOSIS (COW 849)

The marked incoordination of cow 760 on the day following parturition appears to have been due to the rapidity of the decrease in blood glucose; the absolute level was 31.4 mg. per cent and the acetone bodies had increased to only 8.0 mg. per cent. Possibly the slower decrease in blood glucose explains why cow 830 did not exhibit symptoms of ketosis until nine days after parturition.

Examples of the development of ketosis with little or no apparent symptoms are shown in figures 3, 4 and 5. Under ordinary circumstances these cases would not have been recognized as ketosis.

Of the five second-calf heifers included in the study only two developed ketosis and these cases were very mild (fig. 5). All but one of the older cows developed ketosis, and the degree of hypoglycemia and ketonemia was more marked.

There was a close reciprocal relation between the glucose and acetone bodies of the blood during the development of ketosis and during the subsequent periods of recovery. This relationship was not apparent, however,

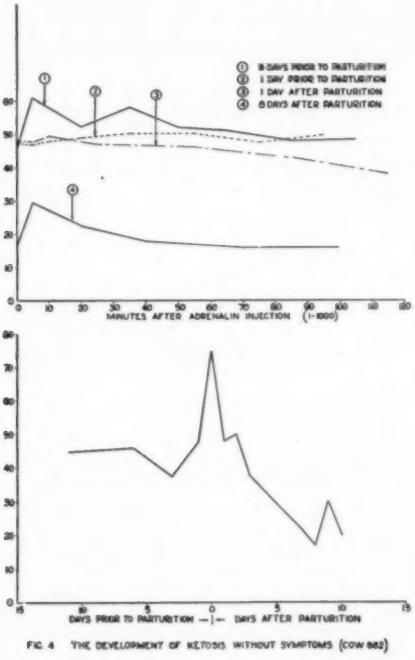
① 5 DAYS PRIOR TO PARTURITION
② 1 DAY PRIOR TO PARTURITION
③ 1 DAY AFTER PARTURITION
④ 5 DAYS AFTER PARTURITION
MINUTES AFTER ADRENALIN INJECTION (+1000)
DAYS PRIOR TO PARTURITION —|— DAYS AFTER PARTURITION

FIG. 4 THE DEVELOPMENT OF KETOSIS WITHOUT SYMPTOMS (COW 882)

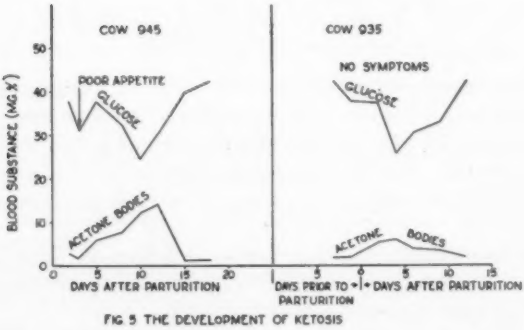

FIG. 5 THE DEVELOPMENT OF KETOSIS

before parturition, although the blood glucose frequently dropped considerably below 40 mg. per cent, as will be noted in figures 1 and 3. The data presented in figure 6 show that the blood glucose also decreased in normal

cows prior to parturition, so that this phenomenon is not necessarily associated with the development of ketosis.

Glycogen storage. The liver glycogen content was estimated indirectly by noting the increase in blood glucose following the intravenous injection

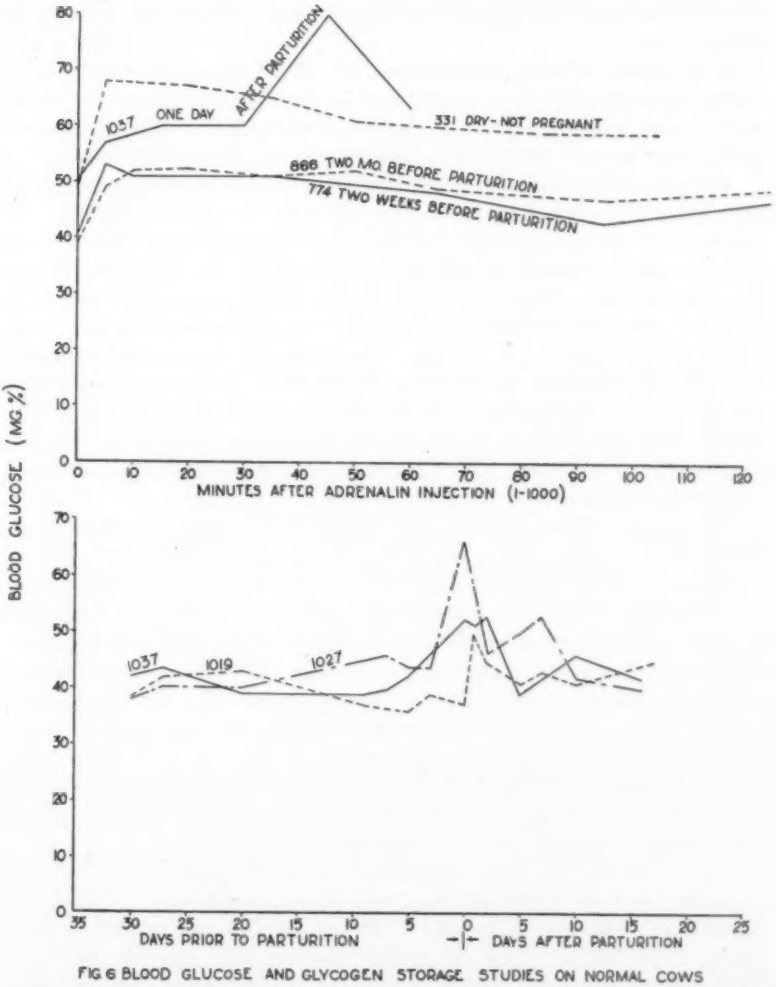

FIG 6 BLOOD GLUCOSE AND GLYCOGEN STORAGE STUDIES ON NORMAL COWS

of 0.5 cc. of adrenalin (1–1000). Such tests were conducted on cows prior to and following the onset of ketosis. For purposes of comparison, similar tests were conducted on cows which were apparently normal. Following the injection of adrenalin, blood glucose was determined at short intervals for

periods of from 45 to 120 minutes. In the presentation of the data these values are presented graphically and will be referred to as glucose curves.

The results of such tests made on cows with ketosis are shown in figures 2, 3 and 4, and on normal cows in figure 6. Unfortunately the glucose curve on cow 760 was obtained after glucose therapy had been resorted to and some degree of recovery had taken place. A marked deficiency of glycogen was indicated, however.

A glycogen test was made on cow 849 (figure 3) a day after the most marked hypoglycemia was observed and again a few days later after partial recovery had taken place. The glucose curves clearly indicate a positive relationship between the glycogen reserve and the degree of ketosis.

The glucose curves on cow 682 (figure 4) are of particular interest as they were obtained both prior to and following the onset of ketosis. The degree of ketosis was indicated by the level of blood glucose. The presence of excess urinary acetone bodies was established by the qualitative sodium nitroprusside test. When compared with the curves for normal cows, shown in figure 6, the tests indicate that the glycogen reserve was somewhat below normal six days before parturition. There was no appreciable increase in blood glucose following the injection of adrenalin one day prior to and one day following parturition although the glucose appeared to be normal. The glucose curve obtained on the eighth day following parturition, when the glucose level was 17.0 mg. per cent, indicates a marked deficiency of reserve glycogen at that time.

Utilization of glucose by cows with ketosis. The three cows 830, 760 and 849 maintained a high level of energy intake but exhibited hypoglycemia and ketonemia for about six weeks and lost flesh very rapidly. Cow 760 received approximately 27.5 pounds of digestible nutrients daily for two weeks before and one week following parturition after which the feed was increased. Prior to this the energy intake was even greater. Maintenance requirements before parturition were 10.5 pounds (Haecker standard). The requirements for maintenance and milk production was less than 27.5 pounds for the first six days following parturition. On the seventh day the total requirements were 27.97 pounds. The other cows in the herd which developed ketosis were fed similarly. A mixed grass and alfalfa hay was fed in addition to beet pulp, hominy, oats, bran, linseed oil meal and molasses.

A few experiments were conducted to ascertain whether or not glucose was metabolized as rapidly in these cows as in normal cows. Glucose was injected intravenously at the rate of 20 gm. per hundred pounds of body weight. The rate at which the glucose was removed was determined by drawing blood samples at 20-minute intervals for glucose analysis following the injection of the glucose.

Glucose tolerance curves were conducted in this manner on cows 830 and 760 and also on a normal cow. Both 830 and 760 exhibited marked hypo-

glycemia and ketonemia. Neither animal had received glucose therapy before these experiments. The results are presented graphically in figure 7. The curves show that glucose was removed from the blood of the cows with ketosis fully as rapidly as from that of the normal cow. The glucose values of 830 and 760 did not decrease quite to the previous low levels, indicating some storage of glycogen and an enhanced ability to maintain the blood glucose level.

Utilization of glucose by the mammary gland of the cow with ketosis. Determinations were made of glucose utilization by the mammary glands of cows with ketosis. Arterial bloods were obtained from the internal iliac by rectal puncture, as in previous experiments, and venous bloods were obtained from the subcutaneous abdominal veins. In addition to the nine

TABLE 1

The utilization of glucose by the gland of the normal cow as compared to that of the cow with ketosis

Normal cows			Cows with ketosis		
Arterial glucose	Glucose utilization	A–V hb. difference	Arterial glucose	Glucose utilization	A–V hb. difference
mg. %	*mg. %*	%	*mg. %*	*mg. %*	%
41.2	9.4	0.68	30.0	11.8	0.49
48.7	10.0	0.38	30.0	11.0	0.60
49.8	7.2	1.12	28.2	10.7	0.53
42.7	9.8	1.22	31.8	14.3	0.30
45.0	6.7	0.00	29.2	9.5	0.00
52.0	12.5	0.00	37.8	7.3	2.65
47.6	10.0	0.58	22.0	9.0	0.00
51.2	10.2	0.00	21.0	10.5	1.41
41.4	11.8	0.00	15.5	5.0	0.00
41.0	12.2	0.53	.....	.....	.....
41.4	12.0	0.00	.....	.....	.....
45.6	9.2	0.00	.....	.....	.....
47.6	11.0	0.00	.....	.....	.....
Average					
45.8	10.2	0.35	27.3	9.9	0.66

experiments on cows exhibiting ketosis, thirteen experiments on normal cows are also shown in table 1. The normal values, obtained from cows in the University herd, represent our best study on normal animals because of improvements in our technique of drawing blood samples and our method of determining whether the animals were unduly disturbed (7).

The average glucose utilization by the glands of the normal cows, with an average arterial level of 45.8 mg. per cent, was 10.2 mg. per cent. The average glucose utilization by the glands of the cows with ketosis was 9.9 mg. per cent, although the average arterial glucose was only 27.4 mg. per cent. Such utilization must exert a severe tax on the ability of other body tissues to obtain sufficient glucose.

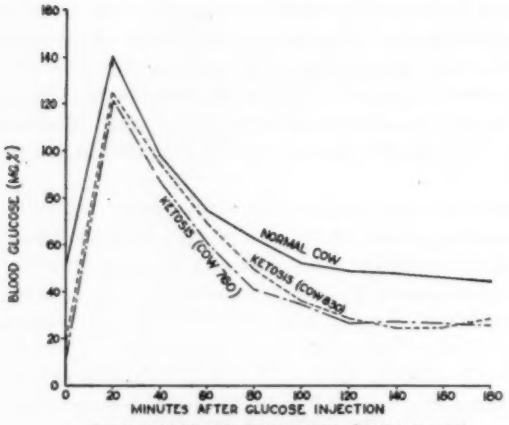

FIG. 7 GLUCOSE TOLERANCE TESTS (20 GM. GLUCOSE PER CWT. INJECTED INTRAVENOUSLY)

The effect of ketosis upon milk production. Studies on ketosis in the field are ordinarily limited to cases of considerable severity in which the animals usually exhibit poor appetite and a marked fall in milk production. Therefore, it has been difficult to determine whether the decline in milk production preceded or followed the loss of appetite and the resulting decrease in food intake.

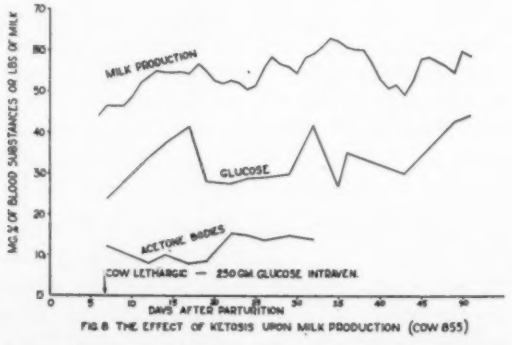

FIG. 8 THE EFFECT OF KETOSIS UPON MILK PRODUCTION (COW 855)

It was the practice in the herd under observation to increase the food intake as rapidly as possible following parturition. Possibly this explains why so many of the animals recovered from ketosis without showing severe symptoms and without necessitating glucose therapy. In some cases where glucose was injected in the early stages of ketosis, before the symptoms were very marked, the animals appeared to recover and showed no further signs or symptoms of ketosis. Frequently such recovery was more apparent than

real. A study of two such cases is presented graphically in figures 8 and 9. Both cows had received glucose intravenously before the beginning of this study and were presumed to have recovered, as the appetite and general appearance were quite normal. However, the blood picture shows that the hypoglycemia and ketonemia persisted for several weeks.

The two cows had excellent appetites and were heavily fed during the periods of observation. It will be noted that the milk production roughly paralleled the blood glucose level. The effect was especially marked in cow 1230 (figure 9), which exhibited a more severe hypoglycemia. In both cases

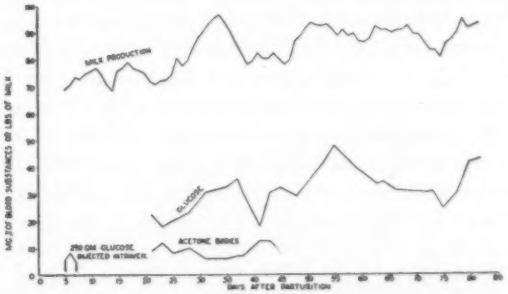

Fig 9 THE EFFECT OF KETOSIS UPON MILK PRODUCTION (COW#230)

milk production appeared to be inhibited from the beginning. Since ketosis begins to develop so soon after parturition, it is probable that milk secretion usually is inhibited from the very beginning in those cows which develop ketosis. The marked decrease often noted later probably reflects merely the severity of the condition. It is significant that fairly good production was maintained in spite of the hypoglycemia.

Feeding soluble carbohydrate prior to parturition. It has been suggested by Duncan *et al.* (2) and by others that ketosis in the ruminant is due to a deficiency in the soluble carbohydrate content of the ration, and the feeding of molasses and dextrose prior to parturition has often been resorted to in an attempt to prevent the onset of this condition.

In this herd, however, liberal feeding of molasses prior to parturition appeared to have little beneficial effect. The most severe case of ketosis observed in this study was that of cow 760. This animal had received two pints of molasses daily for six weeks prior to parturition. Cows 830, 945, 935, 855 and 1230, all of which developed ketosis, each received one pint of molasses daily for approximately a month prior to parturition. Cows 682 and 849, which also developed ketosis, did not receive any molasses.

DISCUSSION

The development of ketosis appears to begin with a depletion of the liver glycogen reserve, possibly caused by liver damage associated with nutrition

prior to parturition. Since the liberal feeding of molasses prior to parturition failed to prevent ketosis, a soluble carbohydrate deficiency is not indicated.

It is apparent that the hypoglycemia observed following parturition is closely associated with the initiation of milk secretion and the demands of the mammary gland for blood glucose. Under normal conditions these demands are apparently not excessive. With depleted glycogen reserves, the sudden increase in the utilization of glucose by the gland would be expected to lower the liver glycogen content still further.

There is some question whether the increase in reducing substances in the blood at the time of parturition is due to an increase in glucose or to the resorption of lactose from the mammary gland. If the increase in reducing substances represents an actual increase in glucose, it is not clear whether it is due to an increased mobilization, associated with the needs of the mammary gland, or to excitation associated with parturition. A sudden increase in the mobilization of glucose undoubtedly takes place with the initiation of milk secretion and probably is a major factor in the development of ketosis. This could account for the development of ketosis if the liver glycogen was low at the time of parturition. Some degree of more or less permanent damage to the liver might account for the failure of many cases to respond readily to glucose therapy. The annual recurrence of severe ketosis in some cows following parturition could also be explained on this basis.

The blood acetone bodies of cows 830 and 760 were higher on the day of parturition than at any time prior to parturition, although the apparent blood glucose was considerably in excess of normal. This would suggest that the increase in blood acetone bodies is due to a decrease in the liver glycogen. It is probable that the development of ketosis is due to faulty carbohydrate metabolism at a time when the demands for carbohydrate are greatest and in which the inability to maintain a normal level of liver glycogen plays a major role.

The glucose tolerance curves and the studies on glucose utilization by the mammary gland demonstrate that there is no impairment of the ability of the various body tissues to utilize glucose.

While milk production is adversely affected by ketosis, the more marked decrease in production so often noted in the field is probably due primarily to a decrease in food intake. By maintaining a high level of food intake, the more severe loss in production can be partially avoided. This has been accomplished in the herd under observation by getting the cows on full feed as rapidly as possible after parturition and by administering glucose at the earliest signs or symptoms of ketosis. In herds where the incidence of ketosis is high it may be expected that many of the animals will develop ketosis without showing any sign or symptoms, and a loss of milk production may be expected because of failure to reach or maintain the peak of produc-

tion during the early part of the lactation cycle. A further adverse effect is indicated, at least in the more severe cases, in the excessive loss of weight which is often observed.

It is apparent that there is little decrease in the uptake of glucose by the mammary gland of cows with ketosis even though the level of blood glucose is considerably below normal. It follows that the increased uptake of B-hydroxybutyric acid by the gland of cows with ketosis (6) is not the result of a decrease in the oxidation of glucose by the gland. The significance of this finding was discussed previously (6, 8).

The feeding regime of the cows in this study did not differ materially from that of many other herds with the exceptions that the energy intake was maintained at a very high level and that very little pasture was available during the summer.

In a continuation of the experiments on ketosis, a study is being made of the effect of the quality and quantity of the ration fed during the dry period upon the ability of the animal to maintain normal glycogen reserves and normal blood sugar following parturition.

SUMMARY

1. Ketosis in cows, as measured by hypoglycemia and ketonemia, began to develop within one to three days after parturition. Prior to parturition there was no ketonemia and the blood glucose values did not deviate markedly from that observed in normal cows.

2. Glucose determinations following the injection of adrenalin showed that the liver glycogen was markedly depleted in cows with ketosis and also indicated that the liver glycogen content was low prior to parturition and the onset of ketosis.

3. Glucose tolerance tests showed that added glucose was removed from the blood of cows with ketosis fully as rapidly as from normal cows.

4. Arteriovenous studies demonstrate that the mammary gland continues to remove a normal quantity of glucose from the blood even in marked hypoglycemia.

5. Milk production is adversely affected in hypoglycemia and ketonemia even when a normal food intake is maintained.

6. The maintenance of a high energy intake prior to and following parturition did not prevent the onset of ketosis.

Most of the analytical work was carried out at the Connecticut Agricultural Experiment Station in New Haven, which is close to the herd on which these observations were made. The author wishes to thank Dr. E. M. Bailey for his courtesy in providing this space.

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THE RELATIONSHIP OF THE SCORE OF BUTTER TO THE MOLD MYCELIA GRADE*

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INTRODUCTION

Due to improper care in production, including lack of cooling and storage at a low temperature, and infrequency of delivery to the butter plant, much cream used for buttermaking is contaminated with mold. If fermented cream is held at a high temperature it is a favorable medium for the development of mold. The grade of cream is not usually determined according to mold standards but according to the grade of butter that can be made from it. When cream is not graded some cream of high mold count is sometimes mixed or blended with a higher grade of cream containing little or no mold. The mixing of the two qualities of cream not only reduces the score of the resulting butter, but increases its mold content as well. If the mold content of the lower quality cream is high, the blending of this cream with a higher quality cream may result in butter that will grade as "unsatisfactory" to the mold mycelia grade. In order to determine the relationship of the score of butter made under Montana conditions from "daily run" commercial churning cream to the mold mycelia grade, this study was undertaken.

PROCEDURE

One pound samples of regular run commercial butter were obtained from the creameries in all parts of Montana in all the seasons of the year. Some of the samples were collected by the State Dairy Division inspectors and some were sent in by the plants to the Dairy Industry Department for the monthly educational scoring. The butter was graded according to U. S. numerical commercial grades by two experienced butter judges because the experimental work was done before the alphabetical grades were introduced. The mold mycelia counts were made by the method devised by Wildman (3).

In accordance with the method of grouping mold mycelia counts published by the American Butter Institute (1, 2), the following grades were assigned to the butter: "satisfactory," if it contained 30 per cent or less mold mycelia; "fair," if it contained 31 to 59 per cent; "unsatisfactory," from 60 to 80 per cent; and "very unsatisfactory" from 81 to 100 per cent.

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RESULTS

Two hundred and eighty samples of butter were studied. Two hundred and one were those sent in by the creameries to the regular monthly educational scoring contests and 79 samples were collected by the State Dairy Division inspectors. The results obtained on these samples are given in table 1.

TABLE 1

The relationship of the flavor scores of the butter to the mold mycelia grade

Score of the butter	No. of samples examined	Number of samples of butter in each mold mycelia grade			
		Satisfactory 0 to 30 per cent	Fair 31 to 59 per cent	Unsatisfactory 60 to 80 per cent	Very unsatisfactory 81 to 100 per cent
93	1	1	0	0	0
92	26	26	0	0	0
91	50	49	1	0	0
90	115	112	3	0	0
89	59	53	4	1	1
88	23	16	5	2	0
87	6	4	2	0	0
Total	280	261	15	3	1

The scores of the butter ranged from 93 down to 87. All the samples scoring 93 and 92 graded "satisfactory" to the mold mycelia grade. Of the 165 samples scoring 91 and 90, one hundred and sixty-one (97.6 per cent) graded "satisfactory" and only four samples graded "fair." The four samples that graded "fair" were churned from sweet and sour cream blended together. The vats of cream from which these samples were made had five per cent of low grade sour cream mixed with 95 per cent of fresh sweet cream. All the other samples were made from regular commercial churning cream. Of the 59 samples of 89 score butter, fifty-three (90 per cent) graded "satisfactory" to the mold mycelia grade. Sixteen (70 per cent) of the 88 score samples graded "satisfactory," five "fair" and two "unsatisfactory." Only six samples scoring 87 were studied, four (66 per cent) graded "satisfactory" and the other two graded "fair" to the mold mycelia grade.

The results obtained indicate that butter scoring 90 or above is relatively free of mold mycelia, providing it is not made from a mixture of high grade and low grade cream. Beginning with the 89 score butter, the per cent of samples grading "satisfactory" to the mold mycelia grade decreased progressively with the decrease in flavor score. Ninety per cent of the 89 score samples, 70 per cent of the 88 score samples and 66 per cent of the 87 score samples graded "satisfactory" to the mold mycelia grade.

SUMMARY AND CONCLUSIONS

1. Two hundred and eighty Montana commercial butter samples scoring from 93 down to 87 were studied. The butter was graded according to U.S. numerical commercial grades by two experienced judges. Each sample of butter was examined for mold mycelia by the Wildman method and the mold mycelia grades "satisfactory," "fair," "unsatisfactory" and "very unsatisfactory" assigned according to the per cent of positive mold fields found.

2. Butter scoring 90 or above graded "satisfactory" to the mold mycelia grade, with the exception of the four samples made from blended cream.

3. The lower the score of the butter scoring under 90, the higher the per cent of samples grading below "satisfactory" to the mold mycelia grade.

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THE INCIDENCE OF OXIDIZED FLAVOR IN THE MILK OF INDIVIDUAL COWS WITHIN ONE HERD*

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The rather general occurrence of oxidized flavor in market milk has been indicated by the work of Trout (9) as well as that of Roland, Sorenson, and Whittaker (7). Guthrie and Brueckner (3) have also reported variations in the tendency of milk from individual cows to become oxidized. They found no correlation between breed, period of lactation or age of cow and development of oxidized flavor. Beck, Whitnah and Martin (1) examined 1127 samples (60–70 cows) of raw milk held 3 days at 40° F. and found an oxidized flavor in 11 per cent of the samples. Oxidized flavor occurred in 6.1 per cent of the Jersey samples, 7.8 per cent of the Guernsey samples, 15.8 per cent of the Holstein samples and 19.4 per cent of the Ayrshire samples. Hening and Dahlberg (5) observed a greater incidence of oxidized flavor in the milk from heifers than from older cows.

Kende (6) and later Thurston (8) classified all milk into three groups depending on its behavior concerning development of an oxidized flavor:

a. Non-susceptible milk—will not become oxidized either spontaneously or upon the addition of metallic salts.

b. Questionable milk—will develop an oxidized flavor only upon the addition of metallic compounds.

c. Susceptible milk—will become oxidized spontaneously or upon the addition of metallic compounds.

EXPERIMENTAL PROCEDURE

Samples were collected from noon milkings by transferring the milk from well-tinned milking pails into pint glass bottles. As soon as possible (within 2 hours) the milk was pasteurized in the bottles at 143° F. for 30 minutes and cooled to 40° F. in an ice-water bath. The fresh milk was divided into two lots; one lot was kept as a control and to the second lot one part per million of copper was added in the form of a one per cent copper sulphate solution. Samples were collected once a month from each normal milk cow in the University dairy herd from March through July and again in September. These cows were all subjected to the same feeding schedule and housing condition.

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TABLE 1

The incidence of oxidized flavor in individual cow's milk

Date	1-day storage				3-day storage			
	No Cu		1 ppm. Cu		No Cu		1 ppm. Cu	
	Samples free from oxid. flavor	Samples having oxid. flavor	Samples free from oxid. flavor	Samples having oxid. flavor	Samples free from oxid. flavor	Samples having oxid. flavor	Samples free from oxid. flavor	Samples having oxid. flavor
March	100	1	19	82	90	11	10	91
April	79	2	16	65	71	10	4	77
May	85	1	26	60	74	12	14	72
June	90	2	22	70	84	8	6	86
July	86	1	22	65	80	7	7	80
Sept.	90	1	11	80	85	6	3	88
Total	530	8	116	422	484	54	44	494

The milks were judged for flavor by the authors after one and three days' storage periods. A rating of zero (0) was given to the sample when it was free from oxidized flavor, a question mark (?) when there was a suggestion of oxidized flavor but not positively identified, and numbers from 1 to 7 indicate increasing intensity of oxidized flavor.

EXPERIMENTAL RESULTS

During the judging of these samples it was observed that different types of oxidized flavor appeared in the various samples. In copper contaminated samples judged after a 24-hour holding period the flavor most often encountered was a metallic-like flavor while the flavor after a three-day storage period was more often a cappy or cardboard-like flavor. This latter flavor was generally not so intense as the metallic flavor and not so readily detected by some individuals. In several samples a very disagreeable oily-like flavor was observed. In some cases samples were free from oxidized flavor after a 24-hour storage period but developed a slight oxidized flavor by the third day. When an oxidized flavor developed in a metal-free sample a strong off-flavor also developed in the copper contaminated sample. Table 1 gives a summary of the flavor studies.

One and forty-eight hundredths (1.48) per cent of the metal-free samples had an oxidized flavor when judged at the end of 24 hours' storage and 10.01 per cent had an oxidized flavor when held 3 days. Of the copper contaminated samples 78.5 per cent had an oxidized flavor at the end of 24 hours' storage and 91.7 per cent after 3 days. Table 2 gives the degree of oxidized

TABLE 2

Total and average oxidized flavor scores for six monthly observations

Month	No. cows samples were taken from	1 day				3 days			
		No Cu		1 ppm. Cu		No Cu		1 ppm. Cu	
		Total*	Ave.	Total*	Ave.	Total*	Ave.	Total*	Ave.
March	101	2	0.0198	322	3.19	37.0	0.366	425	4.21
April	81	6	0.074	232	2.87	31.0	0.383	310	3.83
May	86	3	0.035	189	2.20	25.5	0.297	289	3.36
June	92	4	0.0435	245	2.67	26.0	0.283	337	3.66
July	87	3	0.0345	198	2.27	17.0	0.195	315	3.62
Sept.	91	2	0.0219	260	2.86	19.0	0.208	370	4.07
Total	538	20	0.0372	1446	2.69	155.5	0.289	2046	3.80

* Summation of oxidized flavor scores for the month's observations.

flavor that developed in the milk samples collected from the University herd during the seven-month period.

It was desired to use a rating system whereby the four flavor scores (no copper and 1 ppm. copper at end of one and three days) secured on each sample of milk could be combined to give one value which would serve as an

index to the susceptibility to oxidation of each cow's milk. Although it was realized that any arbitrary system of grouping the four oxidized flavor scores into one value was open to criticism no more accurate procedure could be devised. It was also realized that certain limitations would have to be made of any statistical analysis in which these composite scores were used.

It is difficult to determine how much weight to allow for each flavor observation of a particular sample of milk. It is apparent that metal-free milk which develops an oxidized flavor at the end of one day is much more undesirable than milk which only develops an oxidized flavor when catalyzed by the addition of copper. It was decided to use the average score of the copper contaminated samples held 3 days as unity and then by dividing the average scores for the other three observations into this value factors would be obtained which could be used for weighing the scores. The average scores for 1- and 3-day flavor observations were as follows:

	1 day		3 days	
	No Cu	1 ppm. Cu	No Cu	1 ppm. Cu
Average score	0.0372	2.69	0.289	3.80
Factor	102.0	1.410	13.15	1.00

The factors were rounded out to 100, 1.40, 13.0 and 1.0 respectively.

To compare the individual cows in the herd from the standpoint of the susceptibility of the milk to become oxidized, the oxidized flavor score of each sample of milk with and without copper secured after 1 and 3 days' storage was multiplied by the factor for that particular sample. The sum of the four values thus obtained represented the total weighted oxidized flavor rating of that cow.

TABLE 3

O.F. rating	Degree of oxidized flavor			
	1 day's storage		3 days' storage	
	No Cu	1 ppm. Cu	No Cu	1 ppm. Cu
0	None	None	None	None
0.1 to 5	None	Very slight	None	Slight
5.1 to 10	None	Intermediate	None	Intermediate
10.1 to 15	None	Strong	None	Strong
15.1 to 100	None	Strong	Slight to strong	Strong
Over 100	Slight to strong	Strong	Slight to strong	Strong

Using this method an oxidized flavor rating of zero (0) indicates that the milk is non-susceptible, a rating of 0.1 to 5 indicates a slight oxidized flavor had developed only in the copper contaminated milk, a rating of 5.1 to 10 indicates an intermediate degree of oxidized flavor in the copper contaminated samples, while a rating of 10.1 to 15 indicates a very strong oxidized

flavor in the copper contaminated samples. An oxidized flavor (O.F.) rating in the range of 15.1 to 100 indicates that an oxidized flavor had developed in the metal-free milk by the third day of storage as well as in the copper contaminated samples. Oxidized flavor rating in excess of 100 indicates that an oxidized flavor was observed in all four samples. The significance of these O.F. ratings is given in outline form in table 3.

BREED OF COW AS A FACTOR IN THE EXTENT OF OXIDIZED FLAVOR DEVELOPMENT

To determine if the breed of cows was a factor, the O.F. ratings for the six months were classified on the basis of breed, using the method previously explained. The data are summarized in table 4. From these observations

TABLE 4

Breed as a factor in the occurrence of oxidized flavor

Breed	No. of samples	Per cent frequency of ratings in each class interval					
		Oxidized flavor ratings					
		0	0.1 to 5	5.1 to 10	10.1 to 15	15.1 to 100	Over 100
Ayrshire	60	11.67	30.00	30.00	21.67	3.33	3.33
Brown Swiss	50	6.00	30.00	26.00	32.00	6.00	0.00
Guernsey	66	7.58	21.21	40.91	24.24	4.55	1.51
Jersey	61	9.84	31.15	21.30	24.59	9.85	3.27
Holstein	289	6.92	17.99	32.87	33.20	7.96	1.04

it appears that Ayrshire milk was slightly more resistant to development of oxidized flavor, though differences between the breeds in susceptibility of the milk to oxidized flavor development were not significant. These results are in disagreement with the work at Kansas State College (1) in which it was found that the Guernsey and Jersey milk were the most resistant to oxidized flavor and Holstein and Ayrshire the least resistant. It is probable that individuality of the cow is more of a factor than is breed.

STAGE OF LACTATION AS A FACTOR IN THE INCIDENCE OF OXIDIZED FLAVOR

It is known that the composition of cows' milks varies slightly throughout the lactation period. For this reason it was thought desirable to determine if there was any correlation between stage of lactation and the extent of oxidized flavor. The data developed from this angle are summarized in table 5. The month of lactation was considered as being the two weeks preceding and the two weeks following the time the sample was taken. Stage of lactation did not appear correlated with the degree of oxidized flavor in those samples containing copper (O.F. ratings under 15). There was, however, a much greater incidence of oxidized flavor in metal-free milk during the early part (first few months) of the lactation periods. This is

TABLE 5

Stage of lactation as a factor in the occurrence of oxidized flavor

Lactation period	Number	Frequency of O.F. rating in each class					
		O.F. rating					
		0	0.1 to 5	5.1 to 10	10.1 to 15	15.1 to 100	Over 100
mo.							
0	17	2	2	1	2	8	2
1	47	9	13	8	6	7	4
2	57	4	16	18	13	6	0
3	54	3	10	18	17	6	0
4	57	3	13	20	18	2	1
5	52	0	16	20	14	1	1
6	37	2	8	16	10	1	0
7	42	2	7	18	13	2	0
8	40	4	6	15	15	0	0
9	29	2	3	9	13	2	0
10	33	3	7	6	15	2	0
11	32	1	10	7	13	1	0
12	19	1	2	4	11	1	0
13	1	0	0	0	1	0	0
14	5	1	3	0	0	1	0
15 and over	6	0	2	4	0	0	0

TABLE 5a

Stage of lactation	No. of samples	Number of times oxidized flavor occurred in metal-free milk		Per cent of samples developing oxidized flavor in metal-free milk
		After 1 day's storage	After 3 days' storage	
mo.				
0	17	2	10	58.80
1	47	4	11	23.40
2	57	0	6	10.52
3	54	0	6	11.12
4	57	1	3	5.26
5	52	1	2	3.85
6	37	0	1	2.70
7	42	0	2	4.77
8	40	0	0	0.00
9	29	0	2	6.90
10	33	0	2	6.06
11	32	0	1	3.13
12	10	0	1	5.26
13	1	0	0	0.00
14	5	0	1	20.00
15 and over	6	0	0	0.00
Average				9.10

probably better shown by table 5a, a rearrangement of the data from table 5. Of the 8 cows whose milk (metal-free) developed an oxidized flavor within a 24-hour storage period 6 were within the first month and a half of their lactation period. Twenty-one of the 48 cows whose milk (metal-free) became oxidized within a 3-day holding period were within the first 1½ months of their lactation period. Only 12.10 per cent of the samples judged were from cows in this part of their lactation period. In fact 32.80 per cent of the samples (metal-free) from cows in the first 1½ months of the lactation period developed an oxidized flavor within three days, while only 5.83 per cent of samples from the remainder of the lactation periods developed the off-flavor.

AGE OF COW AS A FACTOR IN THE OCCURRENCE OF OXIDIZED FLAVOR

The data were analyzed to determine whether or not age was a factor in the incidence of oxidized flavor development. The age of the cows was calculated as of March 1, 1941, and rounded out to the nearest year. Monthly O.F. ratings were used in making the correlations. The data are given in

TABLE 6

Relation of age of cow to occurrence of oxidized flavor

Age	No. of samples	Frequency of O.F. rating in each class					
		O.F. rating					
		0	0.1 to 5	5.1 to 10	10.1 to 15	15.1 to 100	Over 100
yrs.							
2	78	0	11	26	29	7	5
3	115	8	13	29	56	8	1
4	92	8	26	27	21	8	2
5	80	6	14	36	18	6	0
6	42	3	16	15	7	1	0
7	48	6	16	13	8	5	0
8	30	4	11	9	6	0	0
9	17	3	5	3	4	2	0
10	6	2	1	2	0	1	0
11	9	0	3	4	1	1	0
12	7	1	1	0	4	1	0

table 6. Two- and three-year-old cows gave milk (1 ppm. Cu added) which developed a greater degree of oxidized flavor than that from older cows. There was likewise a greater incidence of oxidized flavor in 24-hour-old milk (metal-free) from younger cows, 2, 3, and 4 years old than in the case of the older cows. This is further shown in table 6a. The greatest incidence of oxidized flavor development in metal-free milk held three days was in that produced by cows under 5 years of age. The averages are 10.10 per cent for the younger cows and 4.27 for the cows 5 years or older. It was noted that in several instances the milk from heifers in the first month or two of their lactation period gave a strong oxidized flavor at the end of 1 and 3 days

TABLE 6a

Age of cow	No. of samples	Number of times oxidized flavor occurred in metal-free milk		Per cent of samples developing O.F. after three days' storage
		After 1 day's storage	After 3 days' storage	
yrs.				
2	78	5	12	15.40
3	115	1	9	7.82
4	92	2	10	10.88
5	80	0	6	7.50
6	42	0	1	2.38
7	48	0	5	10.42
8	30	0	0	0.00
9	17	0	2	11.75
10	6	0	1	16.70
11	9	0	1	11.12
12	7	0	1	14.30

holding periods both in the metal-free and copper contaminated samples. These results are in agreement with the conclusions of Hening and Dahlberg (5).

RELATION OF MILK YIELD TO DEVELOPMENT OF OXIDIZED FLAVOR

Henderson, Overcast and Wylie (4) suggested that milk produced during high production periods is more susceptible to the development of oxidized flavors than that produced during periods of lower production. To determine if this relationship would hold for the cows in the herd under investigation, the weekly milk yields at the time sample for flavor observations were taken were correlated with the degree of oxidized flavor development. The data are given in table 7. The data do not indicate any correlation between weekly milk yields and susceptibility of the milk to oxidized flavor development.

TABLE 7

Relation between weekly milk yield and extent of oxidized flavor

Weekly milk yield	No. of samples	Frequency of O.F. ratings in each class					
		O.F. ratings					
		0	0.1 to 5	5.1 to 10	10.1 to 15	15.1 to 100	Over 100
lbs.							
0–100	21	4	6	5	4	1	1
100.01–200	140	10	28	40	52	10	0
200.01–300	156	10	37	44	55	7	3
300.01–400	135	6	27	57	33	11	1
400.01–500	45	6	10	11	11	5	2
500.01–600	17	2	5	6	2	2	0
600.01–700	2	1	0	1	0	0	0
700.01–800	1	1	0	0	0	0	0

An attempt was also made to determine if the total amount of milk fat produced is related to the extent of oxidized flavor development. The data are summarized in table 8. These data also fail to show any correlation

TABLE 8

Relation between weekly fat production and degree of oxidized flavor

Weekly fat production	No. of samples	Frequency of O.F. ratings in each class					
		O.F. ratings					
		0	0.1 to 5	5.1 to 10	10.1 to 15	15.1 to 100	Over 100
lbs.							
0–2	2	1	1	0	0	0	0
2.01–4	9	1	4	1	1	2	0
4.01–6	52	7	11	11	20	2	1
6.01–8	100	3	20	31	41	5	0
8.01–10	122	8	24	38	41	8	1
10.01–12	104	2	21	43	32	6	0
12.01–14	68	5	17	26	13	6	1
14.01–16	33	4	7	12	5	3	2
16.01–18	20	5	6	5	3	1	0
18.01–20	11	1	2	6	1	1	0
Over 20	7	2	1	0	1	3	0

between weekly fat production and development of oxidized flavor. This seemed to be true for the metal-free milk as well as the copper contaminated samples. It should be pointed out that the cows in the University herd were fed in such a manner to maintain maximum milk yields. It is possible, therefore, when comparing cows from the standpoint of production and extent and incidence of oxidized flavor if forced feeding had been introduced as a variable different results might have been obtained.

DISCUSSION AND SUMMARY

The occurrence and degree of development of oxidized flavor in the milk of individual cows in the University herd was determined during six months of the year. A portion of the milk sample was kept relatively free from metal contamination and a portion was artificially contaminated with one part per million of copper. The milks were judged for flavor after 1-day and 3-day storage periods. Five hundred and thirty-eight samples were collected from 138 cows over a period of six months (March through July and September). Of the metal-free milk samples, 1.48 per cent and 10.01 per cent had an oxidized flavor after 1- and 3-day holding periods, respectively. Of the samples to which 1 ppm. copper was added 78.5 per cent and 91.7 per cent had an oxidized flavor after 1- and 3-day storage periods, respectively.

The data were analyzed to determine the correlation between oxidized flavor development and breed of cow, age of animal, period of lactation, milk

yield and fat yield. For purposes of analysis the four flavor observations on each sample of milk were weighed and combined to give a single composite value or oxidized flavor rating.

There was little difference between the various breeds so far as occurrence and development of oxidized flavor is concerned, though the Ayrshire breed seemed somewhat less susceptible.

The stage of lactation appeared the most significant factor regarding the occurrence and extent of oxidized flavor in milk from individual cows. There seemed a greater tendency for an oxidized flavor to develop in metal-free milk from cows during the first month or two of lactation than during the later part of the lactation period. There was no marked correlation between degree of oxidation flavor in copper contaminated milk and stage of lactation.

Age of the cow also appeared correlated to the occurrence of oxidized flavors. A more intense off-flavor in case of copper contaminated milk and a greater frequency in case of the metal-free milk was observed in the milk from 2- and 3-year-old cows than for the older animals. Apparently there can be no adequate explanation for this until we learn why various milks behave differently to the development of oxidized flavors.

The milk from first calf heifers in the first month or two of lactation was very susceptible to development of oxidized flavor. The metal-free milk was especially susceptible. It is difficult to adequately explain why age and stage of lactation are correlated to development of oxidized flavor. Several possibilities might be mentioned. As an animal comes into milk production a great load is placed on the milk secreting glands as shown by inflammation of the udder. It is logical to assume that during the first few weeks of the lactation period that the conditions within the udder are not entirely normal. During this period there is a shift from the production of colostrum milk to normal milk. It might be possible for the milk fat to be partially oxidized when it leaves the udder. On the other hand if we assume that milks vary in their susceptibility to oxidation depending on the amount of protective substance they contain, it is possible to assume that less of this material is present in milk secreted during the first part of the lactation period than in the latter part. No proof is available for either of these suggested reasons.

No correlation was observed between milk yield and development of oxidized flavor. Neither was there any correlation between weekly fat yield and development of oxidized flavor.

There are several possible explanations which might be advanced to explain the variations in susceptibility of milk from individual cows to oxidized flavor. These are presented as follows:

1. It is known that when certain anti-oxidant substances (tyrosine, hydroquinone, ascorbic acid, cereal grains) are added to milk that the development of the oxidized flavor can be retarded or entirely prevented. It is

also known that milk can be processed in such a manner (high heat treatment, addition of hydrolytic enzymes) that antioxidant materials are liberated in the milk which retard fat oxidation. It has likewise been observed that milk from cows fed green feeds (high in carotene) is more resistant to oxidized flavor than cows on dry feed. It is possible, therefore, that milk as it is secreted from the cow might normally contain materials similar in nature to the ones mentioned above which have the power to retard the development of oxidized flavor. The susceptibility of the milk to oxidized flavor in turn would be related to the amount of protective material present.

2. It is commonly recognized that in order to prevent deterioration of animal fats that they must be purified as soon as possible after slaughtering. For example, lard rendered soon after butchering, and butterfat stored in the form of pure fat (ghee), have better keeping quality than fats allowed to remain in contact with the non-fatty material with which they are associated in nature. Since milk fat is rather easily oxidized it is possible that milk contains catalytic material which favors fat oxidation. It is reasonable to assume that if such a substance is secreted in the milk that the amount might vary, causing some milks to develop an oxidized flavor more readily than others.

3. Some milks are known to become oxidized within 24 hours after milking even though handled in such a manner as to prevent metal contamination or exposure to sunlight which might suggest that the milk fat is partly oxidized at the time it is secreted. No one has reported detecting an oxidized flavor in milk immediately after it was drawn from the cow's udder. However, this would not preclude the possibility that the milk fat has passed part way through its oxidation induction period at the time of milking and needed only a few additional hours of holding for the oxidized flavor to be evident.

4. Corbett and Tracy (2) have shown that homogenization and agitation retard development of oxidized flavor by enclosing the fat globule in a new protective casein type membrane. It seems possible that milks might vary in the type, amount and composition of the membrane which surrounds the fat globule. In such cases the protective action of this membrane might vary for the same reasons which would explain why milks vary in their resistance to development of oxidized flavor.

It should be pointed out that there is very little proof to support any of the above suggested theories. A more authentic explanation will have to be delayed until further facts can be secured regarding the physiological factors related to milk secretion, or until more complete information is available regarding the minor constituents of milk.

CONCLUSIONS

The occurrence and degree of development of oxidized flavor in the milk of individual cows in the University herd was determined at monthly inter-

vals (March through July and September). A portion of the milk was kept free from metal contamination and a portion contaminated with 1 part per million of copper.

The individual cows varied in their susceptibility to the development of oxidized flavor.

The milk from the Ayrshire breed appeared slightly less susceptible to development of oxidized flavor than the milk from the other breeds (Brown Swiss, Jersey, Guernsey and Holstein).

Milk from cows in the first part of their lactation was more susceptible to oxidized flavor development than that in the latter part of the lactation. Also the milk from heifers was much more susceptible to oxidized flavor than milk from older cows. Milk from heifers in the first several months of lactation was especially susceptible to oxidized flavor development.

There appeared to be no correlation between development of oxidized flavor and weekly milk or butterfat yield.

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SWEETENING POWER OF THE CORN SUGARS IN ICE CREAM

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The purpose of this paper is to present and discuss data upon the effective sweetness of the corn products, dextrose, enzyme-converted sirup, and corn sirup solids, when used with cane sugar in ice cream. The results obtained are in accord with the experience reported by many manufacturers, in that these products are shown to be more effectively sweet than previously published data have indicated.

There are a number of reasons why published sweetness values may be too low. Most of these values have been determined in water solution, and therefore may not be directly applicable to ice cream. Many of the studies concerning effective sweetness were made before the corn sweeteners were the highly purified products that they are today. Furthermore, the standards of comparison have not been uniform.

In a recent paper (2) it was shown that the sweetness of an ice cream could be considered as dependent upon the ratio of the sugar to total water rather than upon the ratio of the sugar to the total weight of ice cream, as has been generally believed.

Since this is the case, it is evident that useful data upon the relative sweetness of the corn sugars as compared with cane sugar, when they are used in ice cream, can be obtained by a study of the amounts of the corn sugars that must be used per unit weight of water in ice cream to obtain in the frozen product the degree of sweetness equivalent to that produced by a definite ratio of cane sugar to water. Since in the use of corn sugars in ice cream it is customary to replace only part of the cane sugar, the experiments were conducted upon ice creams in which from one-third to one-half of the cane sugar was so replaced.

A study of the literature concerning the relative sweetness of sugars indicated that no uniform basis of comparison had been used, and that frequently figures were given with no statement concerning the basis of computation. It is the custom to use cane sugar as the standard, giving it arbitrarily a sweetness value of either 1 or 100. In general, for determining the comparative sweetness of the other sugars in terms of cane sugar, three methods of comparison are in use. In one method the weight of the sugar necessary to make a given volume of water solution as sweet as the same volume of cane sugar solution of known concentration is determined. In another method the weight percentages of the two sugars that give equal

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sweetness in water are compared. A third method is to ascertain the comparative weight of a sugar necessary to sweeten a given quantity of water to the same degree as will a given amount of cane sugar. Of the three methods, the last would seem to be the most satisfactory, as it indicates the comparative weights of sugars that must be added to a given weight of water to obtain the same sweetness. It is certainly the most useful for ice cream studies, in which, as previously stated, the ratio of sugar to water is the true measure of sweetness.

Most of the work upon the sweetness of sugars in water solution was done with solutions so dilute that sweetness could just be detected. However, Dahlberg (1) has shown that the effective sweetness of sugars increases with concentration, and also that two or more sugars in solution together may give a greater effective sweetness than the sum of their sweetening values taken separately.

When ice cream is frozen, the sugar is concentrated into that part of the water not converted to ice. Therefore we might, from Dahlberg's experience, expect the corn sugars to be more effective sweeteners in ice cream than in the mix, due to this concentrating action.

As a preliminary experiment two vanilla creams of identical composition, except that one contained 15 per cent cane sugar and the other 10 per cent cane sugar and 5 per cent dextrose, were compared for sweetness. These creams were hardened at 0° F., then tempered to 15° F. for serving. The comparative sweetness then was determined by a jury of at least ten persons, as was done with all ice creams made during the series of experiments. Comparison indicated that the dextrose-containing ice cream was the sweeter. Numerous check experiments made upon similar samples, and also upon samples containing 13 per cent cane sugar compared with those containing 8.66 per cent cane and 4.33 per cent corn sugar, confirmed this observation. Two methods were then possible for ascertaining the actual effective sweetness of the dextrose. The first was to make up a series of mixes containing, for instance, 10 parts cane sugar and amounts of dextrose sufficient to give an ice cream as sweet as one containing 15 parts cane sugar on the assumption that the effective sweetness of the dextrose was 100, 110, 120, or 130 on the basis of 100 for cane sugar. These ice creams would then be compared for sweetness with an ice cream containing 15 parts cane sugar, to see which assumed value for the dextrose was correct.

The second method of comparison was to prepare a mix containing, for example, 15 per cent total sugar, dextrose and cane sugar, then to add increasing amounts of water to various portions, freeze the mixes and determine which ice cream had the same sweetness as the 15 per cent cane sugar control. With the sugar-water content of this mix known, the effective sweetness of the corn sugar could easily be calculated.

Both methods were used in a large number of experiments where the dextrose-cane sugar sweetened ice creams were compared with cane sugar sweetened ice cream frozen from mixes of 13 and 15 per cent cane sugar for vanilla ice cream and 15 and 18 per cent cane sugar mixes for chocolate ice cream.

The results of both methods applied to chocolate and vanilla ice cream indicated that dextrose monohydrate in frozen ice cream in the presence of cane sugar is one-fifth again as sweet as cane sugar, *i.e.*, it has a sweetness value of 120 compared with sucrose as 100. Under these conditions anhydrous dextrose would have a sweetness of 125.

Similar experiments, wherein the effective sweetness of corn sirup, solids and of enzyme-converted corn sirup was measured, gave sweetness values of 60 for the corn sirup solids and 75 for the solids (anhydrous) of the enzyme-converted corn sirup.

It should be emphasized that these figures indicate the relative sweetness of these corn products compared to cane sugar on a weight basis, that is, by comparing the weights of the corn products necessary to sweeten ice creams containing a given weight of water with an arbitrary weight of cane sugar used in a similar ice cream containing the same weight of water. The dextrose determinations were made where the material was substituted for one-third the usual cane sugar content of the mix; the corn sirup solids and the enzyme-converted corn sirup where they were substituted for half the cane sugar.

Since the corn sirup solids sweetness is 60, and the dextrose hydrate twice that, or 120, it becomes evident that a mixture of 1 part corn sirup solids and two parts dextrose may have the effective sweetness in ice cream of an equal weight of sucrose when it is substituted in amounts up to one-half the sucrose normally used. The effective sweetness of this mixture, in fact, was determined experimentally to be 100 under the conditions imposed.

For the sweetness of dextrose in ice cream, from experiments apparently made upon the mix, Dahlberg assigned the value of 89; for enzyme-converted corn sirup, 67; and for corn sirup solids, 49. His comparison was made on the percentage weight basis, however. If his data are translated to the basis employed in the experiments here described, the values become 88, 64 and 45, respectively. figures markedly lower than appear in these experiments. The values recorded here are, however, more nearly what would be expected from other data presented by him. He shows all three sugars to be at least as effectively sweet as cane sugar when mixed with cane sugar in the proportion of 1 to 2 in a total concentration of at least 40 per cent, a sugar concentration which most certainly would be exceeded in the unfrozen part of an ice cream at normal serving temperature.

The factors determining the final sweetness of an ice cream are many; one experimenter is reported to have a list of well over twenty. The results set forth in this paper, obtained under a rather narrow range of conditions, must not be assumed as applicable to all cases that may occur. On the other hand, the conditions of these experiments are sufficiently representative of ice cream practice so that it is believed that the values obtained for the sweetness of the corn sugar will be applicable in most cases.

It may be concluded, then, from these measurements upon frozen ice cream, that the corn sugars are markedly more efficient sweeteners in ice cream than has been indicated by previous measurements which have been made upon water solutions of these sugars. In fact dextrose hydrate, with a value of 120, is actually sweeter than cane sugar when it is used to replace one-third of the cane sugar in ice cream. The relative values for enzyme-converted corn sirup and corn sirup solids are 75 and 60, respectively.

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AGITATION AND TEMPERATURE OF CHEESE MILK AND THE DEVELOPMENT OF RANCID AND UNCLEAN FLAVORS IN CHEDDAR CHEESE

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A question of paramount importance to the cheddar cheese industry is how to eliminate the off flavors which are responsible for second and third grade cheese and thereby to reduce economic loss due to these causes. This problem may be restated as, what are the causative factors of cheese flavor defects and what remedial measures can be applied to overcome them. In this communication consideration is given to two specific defects, namely, rancid and unclean flavors in cheddar cheese.

Rancid flavor refers to an unpleasant butyric acid-like odor encountered at all seasons of the year in grading raw milk cheddar cheese. It is generally a distinct, typical flavor defect readily recognized by an experienced grader but it may be associated with or partly masked by other off flavors. The seriousness of this defect is indicated by the fact that slightly rancid cheese are second grade and rancid cheese third grade according to Canadian grading standards.

Unclean flavors are less clearly defined but are also of common occurrence. The grader's vocabulary contains such descriptive terms as; "the flavor is nothing great," "not quite right," "off," "something on it," "not quite clean," "unclean," "not clean," "cow's breath," "whey tank," "swill barrel," "dirty," and "resembling rancidity." For the sake of uniformity these flavors will be termed slightly unclean, unclean and very unclean, according to the intensity of the defect. The grade on unclean cheese may be doubtful first grade, as a rule second grade and occasionally third grade.

Rancid flavor is quite well known in raw, late lactation and homogenized milk, in raw cream and in unpasteurized butter. Furthermore, it has been established that rancidity is caused by the hydrolytic decomposition of butterfat through the action of the enzyme milk lipase which is known to be present in all raw milk. Evidence that milk lipase is also the causative agent of rancidity in cheddar cheese includes the resemblance of rancid cheese flavor to that known in other dairy products, the production of rancid cheese from homogenized milk or from milk to which lipase preparations have been added, as well as the negative bacteriological findings on butyric fermentation in cheddar cheese (1, 2).

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TABLE 1

Agitation of cheese milk in relation to cheese flavor

Vat No.	Milk	°F.	Minutes churned	1st grading		2nd grading		3rd grading	
				Age of cheese (days)	Flavor score	Age of cheese (days)	Flavor score	Age of cheese (days)	Flavor score
	Series I								
1E	M	86	15	4	36.0 rancid	20	36.0 rancid	32	36.0 rancid
1C	M	86	.....	4	40.0	20	39.5	32	40.0
2E	M	86	10	13	37.0 sl. rancid	25	36.0 rancid	45	36.0 rancid
2C	M	86	.....	13	40.0	25	40.0	45	40.0
3E	M	86	5	10	38.0 unclean	21	37.0 sl. rancid	41	36.5 rancid
3C	M	86	.....	10	39.5	21	39.5	41	39.5
4E	M	86	3	6	38.5 sl. unclean	18	38.0 res. rancid	39	37.0 sl. rancid
4C	M	86	.....	6	39.0	18	40.0	39	40.0
	Series II								
5E	M	75	5	11	38.0+ unclean	25	38.0– unclean	39	37.5 unclean
5C	M	75	.....	11	39.5	25	39.5	39	39.0
6E	M	65	5	18	38.5 sl. unclean	32	38.0 unclean	60	37.5 unclean
6C	M	65	.....	18	40.0	32	39.5	60	39.5
7E	M	55	5	15	39.0–	29	38.0– unclean	43	38.0 unclean
7C	M	55	.....	15	39.5	29	39.0–	43	39.0–
	Series III								
8E	N	75	5	11	37.5 res. rancid	25	38.5 sl. unclean	39	38.0– unclean
8C	N	75	.....	11	40.0	25	40.0–	39	39.0+
9E	N	65	5	8	38.0 unclean	22	39.0–	36	37.0 unclean
9C	N	65	.....	8	39.5	22	39.5	36	39.0+
10E	N	55	5	18	39.0+	32	38.0 unclean	46	37.0 res. rancid
10C	N	55	.....	18	40.0	32	40.0	46	39.5
	Series IV								
11E	M	75	5	11	39.5	25	38.5 sl. unclean	39	39.0
11C	M	85	5	11	38.0 unclean	25	37.5 unclean	39	37.5 unclean
12E	M	65	5	10	39.5	24	39.0	38	39.0–
12C	M	85	5	10	38.0 unclean	24	37.5 res. rancid	38	37.5 res. rancid
13E	M	55	5	8	39.0–	22	39.5	36	39.5
13C	M	85	5	8	38.5 sl. unclean	22	38.0 unclean	36	38.0 unclean

TABLE 1.—(*Continued*)

Vat No.	Milk	°F.	Minutes churned	1st grading		2nd grading		3rd grading	
				Age of cheese (days)	Flavor score	Age of cheese (days)	Flavor score	Age of cheese (days)	Flavor score
	Series V								
14E	N	75	5	18	37.5 unclean	32	37.0 v. unclean	46	38.0 unclean
14C	N	85	5	18	38.0 unclean	32	37.0 v. unclean	46	37.0 v. unclean
15E	N	65	5	17	38.0 unclean	31	38.0 unclean	45	38.0 unclean
15C	N	85	5	17	39.0	31	38.0 unclean	45	38.5 unclean
16E	N	45	5	15	37.5 unclean	29	39.0–	43	39.0
16C	N	85	5	15	38.0 unclean	29	37.5 unclean	43	38.0 unclean
	Series VI								
17E	N/M	75	5	16	37.5 unclean	30	38.0 unclean	44	37.5 unclean
17C	N/M	75	.....	16	39.0–	30	40.0	44	39.0+
18E	N/4M	75	5	8	39.5	22	39.0	36	38.5 sl. unclean
18C	N/4M	75	.....	8	39.5	22	39.5	36	39.5
19E	N/4M	75	5	18	38.5 sl. unclean	32	38.5 sl. unclean	46	39.5
19C	N/4M	75	.....	18	39.5	32	40.0	46	39.0
20E	4N/M	75	5	15	38.5 sl. unclean	29	38.0 unclean	43	39.0
20C	4N/M	75	.....	15	39.5	29	39.0+	43	39.5

NOTE:—Flavor standards for grades of Canadian cheddar cheese.

First grade cheese—minimum score for flavor 39
Second " " " " " " 37
Third " " " " " " <37
unless below third grade.

The successful reproduction of rancid flavor in cheddar cheese by the methods just mentioned has yielded some useful preliminary data. However, in order to obtain further information which might be more directly applicable to cheese factory conditions it is necessary to reproduce rancidity under conditions simulating those in commercial practice. This has now been accomplished.

It was shown by Krukovsky and Sharp (3) that vigorous agitation of milk greatly increased the activity of milk lipase. The effect was pronounced at higher temperatures but only slight at lower temperatures. Under commercial conditions cheese milk often not well cooled, and morning's milking not cooled at all, may be subjected to considerable agitation at the farm, during trucking over rough country roads, and finally, at the factory when the milk is being run into the vats and when the mechanical agitators are turned on. It appeared logical, therefore, to submit cheese milk to vigorous agitation at various temperatures experimentally and to determine what effect such treatment would have on cheese flavor. The cheese made from milk in which lipase was activated in this manner developed a characteristic rancid flavor. When lipase action was insufficient to produce rancidity unclean flavors resulted. Preliminary phases of these findings have been studied and are here reported.

EXPERIMENTAL

All the experimental work is summarized in table 1 which consists of six series. Each vat of cheese was made using 200 pounds of milk from the Experimental Farm herd following standard procedure for the manufacture of cheddar cheese. The cheese were 10 to 12 pound size. The vat numbers are given in the first column.

The cheese are listed in pairs designated by the same vat number. This means that for each pair of vats all the milk was pooled, the starter added and the milk then divided into two vats which were made simultaneously keeping the conditions as much the same as possible. In this way the resulting cheese were made from milk of identical chemical composition and initial bacterial flora. The letter E following the vat number represents the experimental vat in which agitation and temperature were varied. The letter C following the vat number shows the comparative or control vat in which the above variables were maintained constant through each series.

Both morning's and night's milk designated in the table as M or N were used in this study as shown in the second column.

The third column gives the temperatures to which the milk was cooled and at which the agitation was carried out. In most cases these were identical except in the fifth series, as explained in the discussion of that section.

Column four gives the length of the period of agitation. Agitation was carried out in a Cherry Junior churn, Model 2B, in which the revolution of

the drum is rated at 31 rpm. This was performed immediately after the pooled milk was divided. When two batches of milk were churned the churn was rinsed between churnings.

The succeeding columns give the flavor scores of the cheese at three successive gradings. The cheese were stored at 58° F. for two weeks and then transferred to a 46° storage for the remainder of the time. Before each grading the temperature of the cheese from the colder storage was raised by placing them into the 58° room for two days.

All the grading was done by a commercial grader of many years experience. The nature of the experimental work was unknown to him. This assured unbiassed grading according to commercial standards.

DISCUSSION

Before considering the experimental results in detail several general observations should be made. The flavor score on any pair of comparative vats such as 1E and 1C are strictly comparable due to the fact that the cheese milk for each pair was identical in chemical composition, initial bacterial flora, starter, and the method of manufacture, condition of storage, etc., were strictly parallel. Significance can, therefore, be attached to even slight differences in the flavor score. On the other hand, when comparing the flavor scores of two different cheese such as 1E and 4E or 1C and 4C, etc., it must be kept in mind that these cheese were made on different days, with unavoidable variations in the method of manufacture, milk, starter, and grading period. Significance is, therefore, attached to the general trend of the flavor scores in a given series and not so much to a comparison of the individual grades. Similarly, a strict comparison cannot be made of the flavor scores obtained at the first, second and third grading and again only the general trends are considered significant. Finally, it should be kept in mind that in commercial practice cheese are graded when 10 to 14 days old. Greatest stress is, therefore, placed on the results of the first grading. With these general remarks a more detailed discussion of the data will now be given.

Series I. These experiments were designed to answer the question, what effect has agitation of cheese milk on the flavor score of cheese. An examination of the data in the table reveals several important features. When uncooled morning's milk was agitated by churning for 15 minutes, the curd at all stages of manufacture was definitely rancid and the cheese 1E was also rancid and was scored third grade. As the period of agitation was decreased the flavor score on the cheese increased. A relationship is shown between rancid and unclean flavors, the latter being a form of the former unrecognizable as to its identity. This relation is shown in two ways. The cheese 1E, 2E and 3E were rancid, slightly rancid and unclean respectively at the first grading. This result was due to a decrease in the time of agita-

tion of the cheese milk. Again, cheese 3E, for example, was unclean, slightly rancid and rancid at three successive gradings. This may be accounted for by the continued action of milk lipase in the cheese once it had been activated by the vigorous agitation of cheese milk. For this reason there appears to be a definite tendency for the flavor of the cheese to deteriorate and the differences in the flavor score at first grading are not well maintained. It is hardly necessary to point out that the comparative or control cheese remained first grade throughout.

Series II & III. It was found that using lower temperatures of agitation and milk which had been held over night, as in the second and succeeding series of experiments, certain practical difficulties arose. At times a great deal of fat churned out making strict comparisons impossible. Therefore, a 5-minute period of agitation had to be adopted. It was realized that by doing so the range of flavor defects under study was limited mainly to the unclean flavor. But since a relationship has been established between the unclean and rancid flavors any information about the former should in large part be also applicable to the latter. At any rate, nothing more could be done until some method of circumventing the difficulty of fat separation was found perhaps by adapting a different method of agitation.

The effect of lowering the temperature of agitation of the cheese milk on the flavor score of cheese is brought out by the data in the second and third series. The results show that judging by the scores of the first grading the flavor of the cheese improved as the temperature of agitation was lowered. Under commercial conditions both cheese 7E and 10E would have been passed as first grade. The milk for these cheese was cooled down to 55° F. Milk cooled down to 65° or 75° gave second grade cheese. When the milk received no agitation the cheese were all first grade regardless of whether morning's or night's milk was used or to what temperature the milk had been cooled. The figures for the second and third grading of the E cheese are less revealing but, as in series I, show a gradual deterioration in flavor with time.

Series IV & V. The set up of the experiments in these series is very similar to that of series II and III. In series IV morning's milk for the experimental vats was churned at 75°, 65° and 55° and for the control vats at 85° F. In series V night's milk was cooled to 75°, 65°and 45° F. The experimental vats were churned at these temperatures while the control vats were brought up to 85° F. before churning. The first grading on the E cheese showed that in each case (except 16E) they scored higher than their mates. Differing somewhat from the results obtained in the previous series the relationship between the temperature at which the cheese milk was agitated and the flavor score of the cheese was not apparent at the first grading but showed up clearly at the second grading. The tendency for the flavor score to drop with time of ripening was also not as definite as before.

However, the view that it is worthwhile to cool cheese milk is substantiated by the difference between the E and the C cheese. It may be pointed out that in cheese 15C and 16C there was some fat loss but the results have been included for the sake of completeness.

Series VI. In this series of experiments different proportions of morning's and night's milk were used as shown in the second column in the table, simulating the mixing of these two types of milk at the cheese factory. Morning's milk was 85°–90° F. Night's milk was cooled to such a temperature that when the two were mixed a final temperature of 75° F. would be obtained. All the milk was agitated at 75° F. for 5 minutes except for the control vats. All the control vats were first grade so that little importance can be attached to the mixing of milks.

Examining the results of the first grading it will be seen from the table that cheese 18E had the highest flavor score of the series but gradually declined. (Morning's milk for vats 18 was inadvertently allowed to cool to 64° F. but was rewarmed to 85° and the make proceeded with as usual.) Cheese 17E maintained its flavor while 19E and 20E actually improved in flavor at the third grading. However, no important conclusion can be drawn as to the effect of agitation on mixed morning's and night's milk.

COMMERCIAL IMPLICATIONS

First of all, let us consider the limitations of the agitation of cheese milk by churning. It must not be regarded too literally. There may be important differences between our experimental expedient and the agitation of cheese milk under actual commercial conditions with respect to such factors as shearing, shock vibration, aeration, duration of agitation, etc.

Nevertheless, it has been shown that vigorous agitation of cheese milk activates milk lipase which remains active in the cheese causing the development of rancid and unclean flavors. This finding is important from a practical point of view as factory cheese milk receives a great deal of agitation and rancid and unclean flavors are common. (It should be stated here that allowance must be made for other types of unclean flavors due to bacteriological causes, etc., but we believe that a high proportion of unclean flavors under commercial conditions is of the type studied.)

On the basis of our studies the following recommendation may be made at this stage. *Unnecessary agitation of cheese milk should be avoided* at the farm, in transit, and in the factory previous to setting the vat.

It is also concluded from our work that the temperature at which cheese milk is agitated has an important bearing on the activity of milk lipase and consequently on the flavor score of cheese. The lower the temperature at which cheese milk is agitated the less is the detrimental effect on cheese quality. Although our work did not seem to indicate that complete control of unclean and rancid flavors could be effected by this means alone, here

again it must be remembered that farm and factory practices differ from experimental conditions and that the effectiveness of this method of control may be greater than is indicated. Some support of this contention may be deduced from the work of Krukovsky and Sharp. At any rate the cooling of cheese milk is definitely beneficial.

From bacteriological considerations the practice has been adopted of delivering morning's milk uncooled. This provides optimum conditions for the activation of lipase. It now appears that this practice is unsound. A second recommendation is therefore made that *all cheese milk should be cooled.* Since agitation and temperature are closely associated in the activation of lipase in milk a certain amount of latitude may be allowed here. Milk which is not submitted to much agitation, as in the case of patrons living close to a cheese factory, would require less cooling than milk which is on the truck for several hours.

The above two recommendations if adopted should do much to improve the flavor quality of cheddar cheese.

It may be pointed out in this connection that according to the prevailing conception of milk quality the cheese milk used in our experimental work would ordinarily be considered high quality milk. It was produced under clean surroundings, had a low bacterial count, and gave a satisfactory sediment test. Yet second and third grade cheese were made from it. Obviously, the definition of milk quality for cheese factories should be broadened to include the two factors brought out by this investigation, namely, minimum agitation and cooling.

SUMMARY

1. Rancid and unclean flavors have been produced in cheddar cheese experimentally.

2. Rancid and unclean flavors have been shown to be fundamentally related.

3. The activity of milk lipase is considered to be the causative factor in the development of rancid and unclean flavors in cheddar cheese.

4. Vigorous agitation of uncooled cheese milk is considered to be the method by which milk lipase is activated.

5. The more prolonged the agitation of cheese milk the lower is the flavor score of the resulting cheese.

6. The lower the temperature at which cheese milk is agitated the better the flavor score of the resulting cheese.

7. On the whole, it appears that cheese made from milk in which lipase has been activated will deteriorate in flavor with age. The data, however, do not extend much beyond one month's storage.

8. Recommendations for improving the quality of cheddar cheese flavor have been made and include minimum agitation and cooling of cheese milk.

9. It is suggested that these recommendations be incorporated into the definition of high quality cheese milk.

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ABSTRACTS OF LITERATURE

BACTERIOLOGY

526. Variation of Brucella spp. with Reference to the Bacteriostatic Action of Dyes. GORDON WORLEY, JR., AND JANE READ WORLEY, Brucellosis Research Project, Clayton Foundation, Univ. of Texas, Austin. Jour. Bact., *46*, No. 2: 219. Aug., 1943. Abs. Proc. Local Branches.

Brucella suis was grown on tryptose agar containing basic fuchsin. A few colonies developed, exhibiting the ability to grow well on basic fuchsin agar, a characteristic lacking in the parent strain. The variant cultures could not be distinguished from the parent strains by microscopic appearance, by fermentation reactions, or by colonial appearance on tryptose agar, but gave reactions on dyes which were identical with those of *Brucella melitensis*. D.P.G.

527. Preliminary Observations of Growth of Selected Strains of Brucella in the McCullough and Dick Mineral Base Medium. V. T. SCHUHARDT AND GRACE A. BEAL, Brucellosis Research Project, Clayton Foundation, Univ. of Texas, Austin. Jour. Bact., *46*, No. 2: 219. Aug., 1943. Abs. Proc. Local Branches.

An account is given of the growth factor requirements of selected strains of *Brucella abortus, Br. melitensis,* and *Br. suis* for thiamin, niacin, biotin and pantothenic acid. D.P.G.

528. Viability of Streptococcus Lactis. H. B. NAYLOR, Col. of Agr., Cornell Univ., Ithaca, N. Y. Jour. Bact., *46*, No. 2: 222. Aug., 1943. Abs. Proc. Local Branches. D.P.G.

529. Studies on the Nature and Control of Dissociation in Brucella Abortus. WERNER BRAUN, Div. Vet. Sci., Univ. of Calif., Berkeley. Jour. Bact., *46*, No. 2: 222. Aug., 1943. Abs. Proc. Local Branches. D.P.G.

BREEDING

530. Artificial Insemination. E. E. HEIZER, Univ. of Wisconsin, Madison. Natl. Butter and Cheese Jour., *34*, No. 9: 44. Sept., 1943.

The advantages provided by artificial insemination associations are as follows: superior sires at no greater cost, decreased risk and greater speed in proving bulls, disease control, veterinary service, pregnancy exams, better

cattle market, and elimination of danger of having bull on farm. Such associations to be successful require cooperative spirit, intelligent and adequate membership, capable leadership, limited area and central bull quarters with a suitable laboratory under a competent veterinarian. W.V.P.

BUTTER

531. Chemistry of Butter and Butter Making. V. Methods for Determining the pH of Cream with Standardized Acidity and of Butter Made from This Type of Cream. C. E. PARMELEE, E. W. BIRD, AND D. F. BREAZEALE. Iowa State Col. Res. Bul. 316. 1943.

This study was undertaken to evaluate methods of estimating pH in butter factories and to learn the reasons for variations in results.

The test-tube type of quinhydrone electrode was found quite satisfactory for the dairy industry. A modified Schollenberger calomel half-cell was used with it. Comparisons were made with the hydrogen and glass electrodes, and colorimetric methods.

Dilution of cream increases pH noticeably. The amount of dilution for cream and butter serum for colorimetric method must vary depending upon the type of acid-reducing agent in the cream. Two individuals checked the pH within 0.15 on the same samples by colorimetric tests.

The most satisfactory melting temperature for separating fat and serum in butter was 60° C. for 60 minutes. Results at 95° C. were too low.

The Coleman industrial pH meter (glass electrode) was considered of doubtful value for butter factories, especially under high humidity conditions. The glass electrode gave too low results.

The pH of cream increased with increased percentages of fat but amounted to only 0.06 pH from 0 to 40 per cent fat by the quinhydrone method. The glass electrode gave uniform results for all fat contents. High curd contents gave some variations in pH. Increased salt content lowered the pH. A.C.D.

532. Vacuum Pasteurization of Cream for Butter. G. H. WILSTER, Corvallis, Oreg. Oreg. State Col. Bul. 368. Jan., 1940.

This investigation deals with the vacreator, a vacuum pasteurizer for cream for butter making, developed in New York. It is a stainless steel apparatus in which cream is heated instantaneously by direct steam to 190–200° F. and discharged in a chamber under 6½–11 inches vacuum; then discharged in a second chamber at 161–179° F. under 15 to 20 inches vacuum; then in a third chamber at 28 to 28½ inches vacuum into which the cream is discharged at 92–101° F. This method of pasteurization was compared with vat pasteurization at 155° F. for 30 minutes. The cream was usually sweet in the winter but about ⅔ was sour in the summer.

The quality of the butter made from vacuum pasteurization was generally better when fresh and it kept better in storage. On an average the flavor score was 0.8 higher. The greatest improvement occurred in April, May, and June when the vacuum process removed so much feed, weed, and other extraneous flavors from the cream. The vacuum treatment removed negligible quantities of desirable flavor substances from sweet cream. The vacuum pasteurized cream produced butter of slightly better body and texture.

The geometric average bacterial count of the raw cream was 49,000,000, for the vat pasteurized cream 9,284, and for the vacuum pasteurized 495. No yeasts or molds survived either pasteurization. A.C.D.

533. Selecting Cream to Make Butter That Will Meet Government Mold Standards. J. C. Boyd and J. A. Nelson, Bozeman, Mont. Mont. State Col. Bul. 415. June, 1943.

Samples of cream were collected for this study from two creameries and two cream stations in Montana in the late fall and winter. It was found that good flavor scores of the cream indicating 90 score butter were secured when the cream was less than 6 days old and the acidity less than 0.5%. Such cream and the butter made from it gave "good" mold counts. Lowest mold counts were secured when the cream tested 40 to 50% butterfat. The mixing of 5 to 10% of poor cream with good cream was readily detected by the mold count. The microscope mold count on cream was accurate when the mold content was above 100,000 per ml.

Cream with mold counts of "fair," "doubtful," or "excessive" will make butter of unsatisfactory mold count. A.C.D.

534. Butter Making During Hay Feeding Season. G. H. Wilster, R. E. Stout, R. W. Stein, J. R. Haag, and I. R. Jones, Corvallis, Oreg. Oreg. State Col. Bul. 414. Dec., 1942.

In the winter months from October to March in those areas where alfalfa hay is fed extensively, the butter has a hard, crumbly, or sticky body. This defect seriously affects its quality. Experiments were conducted to study the factors involved and to develop remedial procedures.

It was found that the type of pasteurization did not affect the body of the butter but surface tubular cooling of the cream hardened the body. Extra hardness was secured by cold holding of the cream for long periods of time before churning, and by too cold wash water.

The difficulty could be overcome by following certain procedures in manufacture whose most important points are included in the so-called "50–45–40" method. This means that following pasteurization the cream should be cooled slowly to 50° F. and held overnight, then the butter should

be washed with water not above 45° F., and finally the butter should be stored at 40° F. Many other details are given to aid further in making good butter. A.C.D.

CHEESE

535. Preparation of Starters for Cheese—Buttermilk—Butter. G. H. WILSTER AND F. E. PRICE, Corvallis, Oregon. Oreg. State Col. Bul. 379. Dec., 1940.

Special equipment has been designed to facilitate the handling of starters. This includes a small pasteurization tank for mother cultures, a constant temperature incubator, and a small steam sterilizer for the transfer pipettes for mother culture. Details of the technic for making starters are given. A.C.D.

536. Improved Steam Diffusion Method of Pasteurization for Cheesemaking. N. E. LAZARUS, Buffalo, N. Y., AND WILLIAM J. O'BRIEN, Syracuse, N. Y. Natl. Butter and Cheese Jour., *34*, No. 9: 12. Sept., 1943.

Milk for cheesemaking is pasteurized by direct steam in a special apparatus designed to remove solids and condensate from steam and then to mix the purified steam and milk in a small unit. Temperatures are automatically controlled so that the usual undersirable effects of heating milk with direct steam are avoided. The treatment is bacteriologically efficient and economical. The treatment reduces curd strength which is partially compensated by use of larger amounts of rennet and slightly higher setting and cooking temperatures. Body and texture of cheese is that of typical washed-curd cheese; the flavor is excellent. W.V.P.

537. Standardization of Milk of High Fat Content for the Manufacture of American Cheese. W. S. ARBUCKLE, Dept. Dairy Husbandry, A. & M. College of Texas. South. Dairy Prod. Jour., *33*, No. 6: 12. June, 1943.

Present conditions favor the standardization of milk for cheese making in sections of the country where the Guernsey or Jersey breeds of cattle predominate. Elimination of economic waste in manufacture and the desirability of maximum production and uniform composition recommend the practice.

Three methods have been suggested previously: (1) Adjustment of milk to a casein to fat ratio of 0.7 to 1.0 on the basis of casein and fat tests; (2) the standardization by the addition of milk powder to a fat to solids-not-fat ratio of 1.0 to 2.8 using fat content and lactometer readings, and (3) observ-

ing the analysis of the finished cheese and then adjusting the fat content of the milk accordingly.

When milk was standardized on a basis of fat to total solids a ratio of 1 to 3.3 gave most satisfactory results on preliminary tests at the author's institution.

Standarized milk yields a firmer curd which mats less rapidly. Lower acidities and lower cooking temperatures give better results. The loss of solids-not-fat in the whey is not affected by standardization.

From standardized milk the yield of cheese per hundred pounds of milk is less, the yield per pound of fat greater, and the moisture content of the cheese greater than from normal milk.

Standardization has no appreciable influence upon the quality of the cured cheese. A slight stiffness of body may occur in the fresh standardized cheese but this characteristic disappears in aging. F.W.B.

CONCENTRATED AND DRY MILK; BY-PRODUCTS

538. Seven Ways to Beat Bacteria in a Dry Milk Plant. P. S. PRICKETT, Food Indus., *15*, No. 8: 74–78. 1943.

In this article the author describes the separator as a cause of trouble. Data are presented to show that the hot wells are a source of bacterial difficulties. Temperatures as high as 200° F. are actually required to keep down the thermophiles. The vacuum pan and also the homogenizer require special attention to avoid bacterial difficulties.

The article contains much of practical interest. It indicates that the author has a keen insight into the subject.

The seven factors to beat the bacteria are listed as follows: (1) take away part or all of their water, (2) deprive them of their food, (3) force undesirable temperature on them to make it either too hot or too cold for them, (4) make the environment too acid or too alkaline, (5) give them too little time to multiply and grow by hitting then hard before they get started, (6) treat them with germicidal chemicals or ultraviolet light, (7) shoot steam or elbow grease at them. J.C.M.

539. The Use of Drum Process Skim Milk Powder for Making Cultured Buttermilk. W. M. ROBERTS AND THOMAS B. HARRISON, Dairy Dept., Univ. of Tenn., Knoxville. South. Dairy Prod. Jour., *34*, No. 2: 24. Aug., 1943. F.W.B.

DISEASE

540. Report of Committee on Communicable Diseases Affecting Man. 1942. Internatl. Assoc. Milk Sanit. PAUL B. BROOKS, Chm.,

N. Y. State Dept. Health, Albany, N. Y. Jour. Milk Technol., *6*, No. 3: 152. May–June, 1943.

The U. S. P. H. S. reports 35 outbreaks of milk-borne diseases due to milk and cream in 1940 and 8 due to milk products.

All of the outbreaks due to milk products were classified as gastroenteritis or food poisoning. Of the outbreaks attributed to milk 14 were typhoid fever, 10 were gastroenteritis or food poisoning, 4 were undulant fever, 3 septic sore throat, 2 scarlet fever and 2 were bacillary dysentery.

The Public Health Service report included in the above 43 outbreaks, 7 outbreaks in which milk or a milk product was suspected or the evidence presented seemed inadequate to warrant definite conclusions.

"The Committee respectfully suggests that the Public Health Service in future reports list those outbreaks in which milk is suspected but not reasonably proven to be responsible under a separate heading: 'Outbreaks Possibly Milk-borne.'"

A discussion of milk-borne outbreaks in New York State, exclusive of New York City, shows in the ten-year period 1932–1941, inclusive, that there were 65 milk-borne outbreaks. Of these 62 occurred in rural towns or villages, only three occurred in cities. All were traced to raw milk

L.H.B.

541. Studies of Hydrogen-Sulfide Poisoning. R. W. Dougherty, Robert Wong, and Bert E. Christensen, Corvallis, Oreg. Amer. Jour. Vet. Res., *4*, No. 12: 254. July, 1943.

Sublethal doses of H_2S per rectum reduced the blood CO_2 of experimental animals, but sulfhemoglobin could not be detected spectroscopically. Lethal doses of H_2S produced only traces of sulfhemoglobin in the blood. Animals breathing 10% CO_2 withstood larger doses of H_2S than those breathing air.

An artificial respiration apparatus that prolonged for five and one-half hours the life of guinea pigs given toxic doses of curare did not appreciably prolong the life of guinea pigs given toxic doses of H_2S, thereby indicating that death from H_2S is probably not due to paralysis of the respiratory center alone. That sulfhemoglobin is not the cause of death was indicated by the fact that *in vitro* conversion of part of the blood hemoglobin to sulfhemoglobin and subsequent return of this blood to the circulatory system did not produce death or other ill effects when the sulfhemoglobin content reached as high as 6.9%. It is thought that the toxic action of H_2S is due to its action on some delicately balanced enzyme system. S.A.F.

542. Staphylococcal Antitoxin in the Blood, Milk and Colostrum of Cows. W. T. Miller and J. O. Heishman, Beltsville, Md. Amer. Jour. Vet. Res., *4*, No. 12: 265. July, 1943.

Twenty-five and nine-tenths per cent of 220 cows and heifers had no staphylococcal antitoxin in the circulating blood; 67.4% had less than four units per cc.; and the remainder had from 5 to 64 units per cc. Staphylococcic mastitis was present in all animals showing a titre of 16 or more units per cc. of blood and in some with lower titres. Milk samples from two cows with acute mastitis contained 16 and 32 units per cc., but in 60 samples of normal milk from cows with an antitoxin titre of from 16 to 96 units in their blood, only ten contained antitoxin, and this in a titre of one unit or less per cc. Colostrum, from cows showing a blood titre of the antitoxin, contained appreciable quantities, but this titre dropped rapidly as milk became normal in chemical composition. S.A.F.

543. The Effect of Sulfapyridine on Cows Known to Eliminate Brucella Abortus in the Milk. I. Live, E. L. Stubbs, and M. R. Gardiner, Jr., Philadelphia, Pa. Amer. Jour. Vet. Res., *4*, No. 12: 276. July, 1943.

"The effect of sulfapyridine upon brucellosis in cattle was studied by administering the drug to 6 cows known to eliminate *Brucella abortus* in their milk. Treatment was given for periods of varying length, ranging from eleven to forty-two days. Two of the cows were treated twice, with an interval of twenty-five days. The dosage of sulfapyridine was 7 gms. per 100 lb. of body weight daily during the first week, 5 gms. per 100 lb. daily during the second week, and 4 gms. per 100 lb. daily thereafter.

"The maximum concentrations of free sulfapyridine in the blood and in the milk were attained during the first week of treatment and ranged between 8 and 18 mg. per 100 cc.

"All 6 cows developed anorexia, fever, and leucopenia in the course of treatment.

"Although the administration of sulfapyridine had a bacteriostatic effect upon Brucella, as judged by the decrease in the number of the organisms isolated from the milk, or their total absence during treatment and shortly thereafter, *Br. abortus* was isolated again from the milk of all 6 cows after treatment had been discontinued. Therefore, it must be assumed that the treatment with sulfapyridine did not have the desired chemotherapeutic effect upon brucellosis in the 6 cows." S.A.F.

544. Further Observations of the Use of Iodized Mineral Oil as a Treatment for Bovine Mastitis. D. A. Sanders, Gainesville, Fla. Jour. Amer. Vet. Med. Assoc., *103*, No. 797: 86. Aug., 1943.

From 300 to 500 cc. of a 1 to 1250 dilution of iodine in heavy medicinal mineral oil injected into non-lactating quarters effectively destroyed mastitis organisms. The solution was injected and the quarter massaged and left

until the next lactation period. The treatment was also effective on lactating quarters and as a treatment for acute mastitis, not creating additional inflammation. In either case, the quarter was stripped, the solution injected, and left for 24 hours. Treatment could be repeated at 24-hour intervals.
S.A.F.

545. Salmonellosis of Calves in Tropical Countries. R. PLATA GUERRERO, Guayaquil, Ecuador. Jour. Amer. Vet. Med. Assoc., *103*, No. 798: 152. Sept., 1943.

Salmonellosis, caused by *Sal. enteritidis* Gaertner, is the most important cause of calf losses up to four months of age in the tropical countries of Ecuador and Colombia, the mortality usually being about 60%. Symptoms are those of an acute septicemia and post-mortem lesions chiefly acute enteritis and congestion of the liver, spleen, and lungs. Chronic cases exhibit broncho-pneumonia and necrotic foci in the liver. Vaccination, intestinal antiseptics, and sulfonamide drugs have all been used more or less successfully for treatment. S.A.F.

546. Agglutinins in Swine Blood Serum following the Feeding of Bovine Fetal and Placental Tissue Infected with Brucella Abortus. C. M. HARING, Univ. California. Jour. Bact., *46*, No. 2: 223. Aug., 1943. Abs. Proc. Local Branches. D.P.G.

ICE CREAM

547. Report of Committee on Frozen Desserts Sanitation. Internatl. Assoc. Milk Sanit. F. W. FABIAN, Chm., Mich. State Col., East Lansing, Mich. Jour. Milk Technol., *6*, No. 3: 157. May–June, 1943.

The shortage of essential materials and labor in the ice cream industry is going to require closer supervision on the part of health agencies. If the burden becomes so great as to choose between checking raw or finished product, the greater emphasis should be placed on the finished product.

Reports of individual members of the committee are given.

The Manufacture and Sale of Ice Cream in Canada During the Year 1942. W. C. Cameron, Ottawa, Canada.

The standards for ice cream in Canada were revised in June as a war measure act in order to conserve milk fat.

The revised standards are "milk fat not less than 9.5% and not more than 10.5% by weight for both plain and fruit ice cream; total solids not less than 34% by weight, and food solids per gallon not less than 1.7 pounds of which not less than 0.47 pounds shall be milk fat. In addition a gallon of ice cream must weigh not less than 5 pounds." The regulation regarding

sugar has also been revised to permit the use of sugars other than sucrose in ice cream. "This revision permits the use of honey and combinations of not less than 75% sucrose with not more than 25% of such sugars as dextrose and glucose."

Report of Andrew Krog, Plainfield, New Jersey.

The army's bacteriological specifications requiring that ice cream offered for sale to its agencies be free from coliform organisms in one milliliter portions, has done more to improve the quality of ice cream manufactered for sale in New Jersey from a bacteriological standpoint in one year than all other factors had in the preceding ten. It has been the means of getting many ice cream manufacturers to establish rigorous coliform control in their plants.

The army considers ice cream as a food rather than as a "confection."

The sugar situation still necessitates the use of substitutes, and as long as the materials used to replace sucrose are as wholesome and digestible as sucrose, there should be no objection to intelligent substitution.

Minimun weight or overrun control should be adopted and enforced.

The use of plastic cream, and butter made from plastic cream for ice cream purposes should be considered by the committee as well as the use of dried buttermilk as an ingredient in ice cream mix.

Plant equipment must receive proper care and be operated at peak efficiency, and sanitation standards must not be lowered.

Report of L. C. Bulmer, Birmingham, Alabama.

The ice cream industry should dispense with its so-called nickel ice cream novelties and water ices. Expansion of the industry at this time should be checked to conserve vital dairy products so that they may be put to better use in the "war effort." Curtailing expansion would also relieve strain on transportation facilities, labor and pasteurization equipment, which may be needed to be transferred to the fluid milk industry because of the growing serious shortage of such equipment.

Report of John M. Scott, Gainesville, Florida.

Florida requires that all milk and cream used in making ice cream must be inspected at the source, and all plants where ice cream or ice cream mix is manufactured must be regularly inspected. All mix must be pasteurized.

Counter-type freezers have been a problem. It is required that each freezing unit and hardening cabinet be completely enclosed with suitable impervious material to protect the product from possible contamination from customers. Floors in these freezing rooms must be of impervious material to prevent absorption of moisture and enable them to be easily cleaned.

Metal wash sinks, hot water, brushes, alkali and steam are required for cleansing these freezers.

During winter season transient ice cream manufacturers migrate to Florida. The State requires them to pay a $10.00 license fee for each stop

they make within the State. They must comply with the same regulations as those required of the counter freezer operators.

Imitation ice cream cannot be sold in Florida. L.H.B.

548. The Minnesota Babcock Method Applied to Concentrated Milk, Chocolate Milk and Ice Cream. W. CARSON BROWN AND L. M. THURSTON, W. Va. Agr. Expt. Sta., Morgantown, W. Va. Jour. Milk Technol., *6*, No. 3: 136. May–June, 1943.

The following factors were studied to determine their effect upon the accuracy of the Minnesota Babcock test for the above products when compared to the gravimetric or ether extraction method: the digestion temperature, shaking during digestion, length of digestion period, temperature of water bath, and use of glymol.

From this study they recommend the following procedure:

"Weigh 9 grams of prepared sample into each of two 20% ice cream test bottles. Add 15 ml. of Minnesota reagent. Shake thoroughly. Digest 12 to 15 minutes in a gently boiling water bath, having the bottles in a rack held at least 2 inches above the bottom of the bath. Shake the tests vigorously at the time when at least half the contents of the bottle have turned dark brown (usually about 2½ minutes after placing them in the water bath). Shake vigorously again about one minute later. (Note: Some care may be necessary when starting to shake the bottles the second time as the alcohol in the reagent may boil off through the neck of the bottle taking with it some of the mixture.) Place the tests in a centrifuge and centrifuge them for one-half minute at the speed used for the regular Babcock test. Add hot water (130°–140° F. or 54.4°–60.0° C.) to float the butterfat well up into the neck of the test bottle. Centrifuge for one-half minute. Place the tests in a water bath at 133°–137° F. or 56°–58° C. and leave for 5 minutes. Just before reading test allow colored reading fluid (such as glymol) to flow gently onto the surface of the fat column. Hold the bottles in a level position and read as one would read a Babcock cream test. To secure accurate readings apply divider points to the smooth side of the bottle neck. When adjusting the lower point of the dividers keep the eye on a level with that point and when adjusting the upper point raise the eye accordingly. Average the duplicate determinations."

Using the above procedure the authors obtained results that checked very closely with the gravimetric method on ice cream mix, evaporated milk and sweetened condensed milk; however, only a small number of samples were tested.

The authors report that the test failed to give satisfactory results on any chocolate flavored product, either chocolate milk or chocolate ice cream, and none of the results were tabulated for that reason. L.H.B.

MILK

549. Irregularities in the Agar Plate Counts of Pasteurized Market Milk. W. L. WILLIAMS, Dept. of Bact., School of Med., Univ. of Louisville, and the Bact. and Serological Labs. of the Louisville and Jefferson Co. Health Dept., Louisville, Ky. Jour. Milk Technol., *6*, No. 3: 133. May–June, 1943.

A comparative study of bacterial counts using the old standard agar and the T-G-E-M agar showed the much higher counts obtained on the T-G-E-M agar on pasteurized milk was due in most cases to thermoduric organisms.

Contributing causes most evident to high thermoduric counts were found to be: 1. Open seams in cans and pails. 2. Failure to clean milking machines. 3. Incomplete chlorination.

Laboratory pasteurization and plating of raw milk supplies aided in detecting and lowering the incidence of thermoduric organisms from 10 per cent to less than one per cent. L.H.B.

550. The Status of Regulations and Practices in Determining Extraneous Material in Milk. K. G. WECKEL, Dept. Dairy Indus., Univ. of Wis., Madison. Jour. Milk Technol., *6*, No. 3: 146. May–June, 1943.

Information presented was obtained from questionnaires (16 questions) submitted to milk sanitarians in practically all geographic areas of the country, including large, medium and small communities and state regulatory agencies. Replies were received from 123 community sanitarians and from 44 state sanitarians.

The survey indicated that there is a decided lack of uniformity in the use of the sediment test for grading milk.

Some of the things brought to light were: Approximately one-fourth of the community milk control officials and one-sixth of the state officials reported that they did not use the sediment test. More off-the-bottom type of testers were used than of the transfer type.

The filtering area of sediment discs when in place in testers varied considerably; diameters of 7/8″ to 1–9/16″ were reported.

The time interval for sampling milk for sediment was not uniform. The most frequent interval used was monthly.

There was a decided lack of uniformity in sediment standards used for grading sediment discs.

"There is a growing feeling on the part of many sanitarians that what is called 'acceptable milk' should be amply and clearly defined." L.H.B.

551. Checking Commercial High-Temperature-Short-Time Pasteurization Installation. L. E. HOLT, Pasadena Health Dept., Pasadena, Calif. Jour. Milk Technol., *6*, No. 3: 142. May–June, 1943.

A complete discussion of what constitutes properly operated installations of high-temperature-short-time holding systems is given together with methods to be followed for checking such operation.

Formula for determining the capacity of a high-temperature-short-time unit is given, with two examples for its use.

EXAMPLE 1

If the desired capacity of the unit is 11,000 pounds per hour, what capacity will be needed for the holder tube to insure 11,000 pounds?

$$\frac{11{,}000 \text{ lbs.} \times 15 \text{ (seconds holding time)} \times 1.1 \text{ (safety factor)}}{3600 \text{ (seconds per hour)}} = 50.42 \text{ lbs. or capacity of holder tube use.}$$

EXAMPLE 2

Given the size of the holder tube, how can the capacity of a unit be determined?

$$50.42 = \frac{\text{"x" times 15 (seconds holding time) times 1.1 (safety factor)}}{3600 \text{ (seconds per hour)}}$$

$16.5\,x = 181{,}512$ or (50.42×3600)

$x = 11{,}000$ lbs. or capacity of unit.

"The author believes that the pasteurization of milk by the high-temperature-short-time method is safer and has many advantages over the 'holding' method. Proper supervision must be maintained over each installation." L.H.B.

MISCELLANEOUS

552. If You Want That Army Order, Here is the Right Procedure. ANONYMOUS. Food Indus., *15*, No. 10. 1943.

The Office of the Quartermaster must know about all available foods. New foods must be quickly appraised and classified.

Food items classified as existing specified products should be referred to the Subsistence Branch of the Storage and Distribution Division, Office of Quartermaster General, Washington, D. C.

New foods can be referred to the above address or to the QMC Subsistence Research Laboratory, Chicago, Illinois.

Specifications may be given out by the Army offices. This article presents a detailed account of procedures, places, and men concerned with Army food supplies and methods. Schemes for classifying foods on food value basis are listed. J.C.M.

553. Meeting the Safety Problem. R. J. CROSBY, Marsh and McLennan, Inc., New York, N. Y. Food Indus., *15*, No. 10. 1943.

The writer gives an analysis of plant accidents. His first description deals with hazards and how to avoid them.

Machines, floors, departments, tools and many other agencies are listed as hazards.

In milk plants cracked bottles should be watched. Broken glass should never be thrown into a receptacle. Hands should be protected in picking up broken glass and broken glass should always be removed from working areas.

Employers should make employees accident conscious. Employees should be cautioned by the managers. All accidents should be carefully studied. J.C.M.

554. Effect of the War Situation upon Equipment and Materials. O. K. BURROWS, Pub. Relations and Personnel Dir., Cherry-Burrell Corp., Chicago, Ill. Jour. Milk Technol., *6*, No. 3: 168. May–June, 1943.

Metals commonly used in making milk handling equipment, such as stainless steel, copper, tin, aluminum, lead, and zinc are also needed in our war machines, and the supply available for the dairy industry for making new machinery is practically nil. Even materials for repair and replacement parts have been cut in many instances from one-half to one-tenth of the quantities requested.

Manpower skilled in fabricating these materials for dairy equipment has been lost to other industries in war work.

Some substitute materials have become available, and research will continue to find more.

Inspectors can help in the following ways in this crisis.

1. Be as lenient as possible in your inspection under present conditions, commensurate with safeguarding public health.

2. Advise and guide your plant owners in repair and replacement of equipment. Keep reminding them to repair overworked equipment before it breaks down.

3. Urge your plant owners to run longer hours if possible rather than increase equipment capacity.

4. Get your advanced practices and new ordinances on the statutes, then make allowances to suit the present situation.

5. When a real need for equipment exists and when public health is really in danger, then insist on new equipment. Help your plant owners by writing letters supporting either their PD–1A or PD–414 applications. Be specific, give facts, write a full report as to why change is necessary. There

is still some equipment available. WPB officials do not want epidemics to cut down war production anywhere due to a contaminated milk supply increasing "absentee" reports.

It will help if your letter is notarized, thus avoiding fear on the part of WPB officials that the case is not really justified.

6. Every plant has lost skilled manpower. Help your plant owners by making helpful suggestions to "green" help. Help educate them to dairy industry sanitation standards. L.H.B.

555. A Manual of Dairy Detergents and Cleaning Practices. M. E. PARKER, Food Indus., *15*, No. 8: 71–73. Aug., 1943.

In this article wetting agents, soap powders and polyphosphates are described. The article also goes into the subject of abrasives. There is an excellent table which gives the names and manufacturers of dairy cleaning compounds. J.C.M.

556. The Sanitation of Pryex Glass Tubing Used to Replace Metal Tubing in Food and Dairy Plants. G. J. HUCKER, N. Y. State Agr. Expt. Sta., Geneva. Jour. Bact., *46*, No. 2: 220. Aug., 1943. Abs. Proc. Local Branches. D.P.G.

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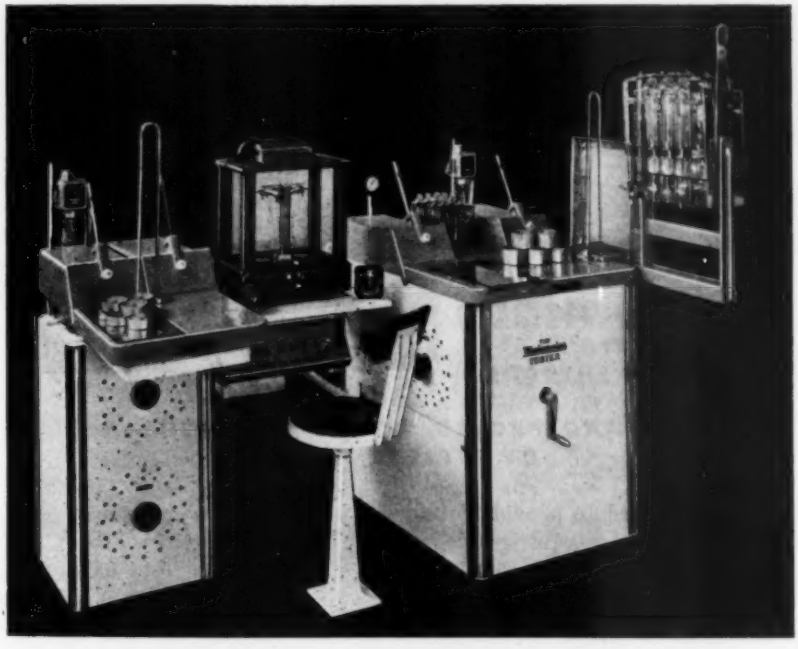

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To all early peoples, Nature was a mysterious thing. Food could only be gotten where Nature had accidentally placed it. Man was a nomadic wanderer in search of the necessities of life. "Moving day" was a "must," not a choice.

Eventually, some independent thinker in the tribe (probably egged on with the desire to stay put for a change) found that he could artificially plant a seed in a Man-made hole in the ground. . . . The original backyard garden was born. . . . Community existence began.

But these people were still at the mercy of the elements. It is easy to understand how they came to worship the winds and the rains and the sun and even the food itself. The simplest incidents and experiences of every-day life were surrounded with supernatural mumbo-jumbo. If land became exhausted, that was charged to "evil spirits" at work.

But to bring the picture closer to our day, it seems almost unbelievable that less than 175 years ago, Adam Smith, the great economist of that day, wrote that "The quantity of well-cultivated land must be in proportion to the quantity of manure which the farm itself produces; and this again must be in proportion to the stock of cattle which is maintained upon it." With all his wisdom, he couldn't foresee that this seemingly insurmountable obstacle to the further development of agriculture would be conquered through chemical science seventy-five years later.

However, when in the middle eighteen hundreds a great student of chemistry announced the discovery that phosphorus, nitrogen and potassium were the elements that must be restored to the soil in added fertilizers, a bitter argument sprang up. Some deemed it "against Nature" to secure these needed chemicals from any source other than manure. So they dubbed these new fertilizers "artificial," which meant—to the uneducated—something direct from Satan.

But the pioneers thus made it possible for the same piece of ground to yield food over many years. They found that the vital elements for plant food occurred in many forms and in many places over the earth. Man had to have the intelligence and energy to convert them and to bring them from where they existed to where they were needed.

And so, that which was once called "artificial" has now become the mainstay of world agriculture.

Vanilla is certainly a case in point. Man has brought this flavoring to its peak of delicious mellow-mildness by processing and combining Nature's offerings. First, he lifted the vanilla vine out of the forest and by scientific cultivating and curing he continues to improve the vanilla bean's yield of vanillin and other flavoring constituents. Next, when he found that the bean was unable to produce sufficient vanillin for the ideal proportion with its other aromatics, he turned to other sources for the added vanillin needed to round out the vanilla flavoring.

Fortunately, those who see Nature's raw gifts in the right perspective have never been discouraged by the traditions of the slower thinkers. Frequently, that which is currently termed "artificial" is the improvement which Man has made by processing the offerings of Nature.

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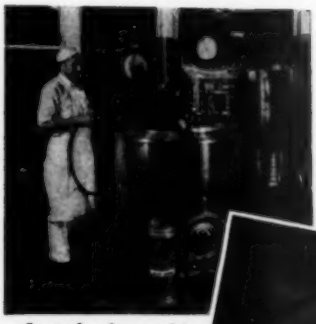

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